COSMOLOGY OLD & NEW

BEING

A MODERN COMMENTARY

ON THE

FIFTH CHAPTER

OF

SHRI TATTVARTHADHIGAMA SUTRA

BY

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AUTHOR'S PREFACE

IT was late Jain Dharmabhusan Brahmachari Sital Prasad who made me write this book and it is indeed very sad that he has not lived to see the publication of it. The late Brahmachari was inspired with the idea of bringing to light the ancient knowledge of the Jains in different branches of science in a language understandable by all. Accordingly, when through his exhortation, the Trustees of the late Rai Bahadur J. L. Jaini's Estate asked me to write a modern commentary on the fifth chapter of Shri Tattvarthadhigama Sutra I could not refuse. The work was undertaken in the January of 1937 and was completed by the middle of 1938 but circumstances prevented its publication for about four years.

As has been remarked by Fermor, Asia has not been scientifically asleep during the whole of the several millennia before the introduction of modern science into India by the Europeans. Researches by oriental scholars into the old Sanskrit and Pali texts are gradually bringing to light the valuable gems of the cultural heritage of India. The Jains and the Buddhists made discoveries of immense value. In fact Dr. N. R. Dhar has attributed the intellectual stagnation in India after the 12th century to the decline of Buddhism under whose ægis science had considerably developed. About the contributions of the Jain thinkers in the field of physics, biology

and mathematics very little is known to the intelligent public for want of popular literature on the subject. The present is an humble attempt to put before the English-knowing public the contributions of the Jains in the domain of cosmology and atomic physics. It is not an attempt to seek in ancient texts the substance of modern theories, as some are likely to think, nor is there any attempt to bring by forced, distant and misleading analogies the ancient discoveries in line with the modern science. The points where the two agree and where they do not have been laid bare.

One is apt to ask: how is the present work going in any way to serve the cause of the Jain religion or of science ? My answer is that the present work is only one link in the chain. The Publishers have under contemplation similar commentaries on the subjects of biology, geography, etc., and when the chain is complete the world will know the peculiar merit of the Jain religion that it has treated not only the problems of soul, truth and *ahimsa* in a rational way but that it deals with matter and the physical universe in quite the same manner. With regard to the cause of science, some day some physicist, like our eminent Jain physicist Dr. D. S. Kothari of Delhi University, may take up some prediction of the Jain physics, work it out mathematically and astonish the world The 'animistic' belief of the Jains that the plants are endowed with life has already been demonstrated wonderfully by late Sir J. C. Bose, F. R. S. Who can say that the development of the mercury-vapour turbines in America is not

the outcome of the descriptions of the mercury vapour engines occurring in ancient Jain and Buddhist works like the *Samarangan Sutradhar* (समरांगण सूत्रधार) and *Silpa Samhita* (शिल्प संहिता) ? Not only in America, but also in Germany an attempt was made to replace petrol engines by the mercury vapour engines in the aeroplanes. The translation of *Surya Pragyapti*, a standard Jain work on astronomy, into the German language has elicited high admiration in the West.

We draw the attention of the scientists towards the following facts particularly :

(*i*) Jains assert that the size of the universe is fixed (343 cu. rajjus). The red shift of the spectral lines must be attributed to some other cause, not to the expansion of the universe*.

(*ii*) Aether, the medium of motion, cannot be eliminated out of the scheme of the universe. It is a non-material medium and all attempts to associate physical properties with it are bound to fail.

(*iii*) Aether is the seat of a stationary system of waves.

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*Zwicky has already given an alternative explanation. According to him when light passes a large mass such as a star, not only is it deflected but it also deflects the mass to a small extent. Thus it loses energy. According to quantum theory this means a diminution in the frequency of light and hence an increase in the wave-length *i. e.* the light looks redder or the spectral lines are shifted towards the red.

(*iv*) The Field or the medium of rest, through which the forces of gravitation and electromagnetism operate, is quite a separate reality, non-active and non-material. Its functions cannot be usurped by the Space.

(*v*) Space without matter and time does not mean void : space is a substance and a reality in itself in which the property of expansion inheres.

(*vi*) Space and time form a mixed continuum and this four-dimensional continuum forms a finite universe beyond which no particle of matter or energy can travel on account of the absence of aether but beyond this finite universe there is an infinite extension of pure mathematical space.

(*vii*) The postulate that the space becomes warped in the presence of matter is unnecessary at least in the explanation of a finite universe.

(*viii*) According to the Jain view, even the modern atom is a molecule (*skandha*) and Raman effect would be discovered in the atoms also some day.

(*ix*) According to the laws of union of the elementary grains of energy mesotrons, positive and negative, of different masses are possible.

Many more such ideas will be found dispersed in the main text and in Jain literature in general. For instance, it is mentioned in the *Gommat Sar* that the shape of a *parmanu* is hexagonal.* A free *parmanu* can travel with a maximum velocity of 14 rajjus per *samaya* (the unit of time) *i. e.* it can shoot from one corner of the universe to the other in one *samaya*, provided it does not meet any collision. This is the maximum velocity possible in Nature just as, according to Einstein, the velocity of light is the limit. At each successive collision the velocity is reduced. The maximum age of a star is given as a little more than one *palya* (पल्य) ($=4{\cdot}13\times10^{46}$ years) showing that in the life-cycle of a star there are stages of infancy, puberty, old age and death corresponding to the modern idea of the evolution of a star. The modern view is that a star starts its career in the form of cold cosmic dust, gradually and steadily contracts and heats up to very high temperatures, then flares up as a *novae* or a *supernovae* giving out enormously bright light, leaves a residue (called a white-dwarf star) which is dark and thus disappears from view.

In the end, the author has great pleasure in thanking Babu Ajit Prasad Jain, M. A., LL.B., of Lucknow, the veteran leader of the Jain Community, for his kind help in reading through the MS. and giving valuable suggestions.

*It should be remembered that no one has yet seen the atom with the eyes. The best microscopes fail in this respect. The atom models proposed by the scientists are as much like an atom as a railway map is like the actual railway it represents.

We shall be very grateful for pointing out errors and omissions and for giving useful suggestions. Healthy criticism on the subject is invited.

GWALIOR. G. R. JAIN.
8th November 1942,
(Lord Mahavir's Nirvána Day).

THE PROLOGUE

श्री जिनेन्द्राय नमः

मंगला चरण ।

नमो नमः सत्वहितंकराय, वीराय भव्याम्बुज भास्कराय ।
अनन्तलोकाय सुरार्चिताय, देवाधिदेवाय नमो जिनाय ॥१॥

स्वदोष शान्त्या विहतात्मशान्तिः शान्तेर्विधाता शरणंगतानां ।
भूयाद्भव-क्लेश-भयोपशान्त्यै शान्तिर्जिनो मे भगवान शरण्यः ॥२॥

(*Swami Samantbhadra*)

I bow to Lord Mahavir, the great well-wisher of all living-beings; the source of joy to the souls of the Universe; the one who is worshipped by all celestials and the lord of gods.

I seek protection of Lord Shantinath, the Incarnation of Peace on earth, for by annihilating all lusts and desires of the flesh He has obtained the highest equanimity of mind and confers peace on those who lie at His feet.

The present work is a commentary on the Fifth Chapter of Tattvartha-adhigama Sutra of Shri Umaswami Acharya (135–219 A.D.), who was the most famous disciple of the universally worshipped saint, Kunda-kunda-charya. The relationship between Kunda-kunda and Umaswami is established by inscription No. 108 of 1365 Saka Samvat, found at Sravana Belgola in Mysore State.

Authoritative Character of Tattvartha Sutra.

J. L. Jaini of sacred memory has called Tattvartha Sutra the *Jain Bible.* It is held

in high esteem by all sects and sub-sects of *Jainism. There is no portion of Jain philosophy* which is not embodied in this sacred epitome. Like the Ramayan of the Hindus or the Quran of the Muslims it is recited every day in the temples and in millions of Jain homes.

Spirit of Modern Science.

This world of ours is dynamic, not static. It is ever changing and progressing in a forward or a backward direction. Like the spokes of a wheel the rise and the fall follow in succession. Jain Acharyas have divided the cycle of time into Utsarpini and Avsarpini, *i. e.*, the time rising and falling with a slow serpentine motion. The rise of the sun to the zenith and its fall again every evening is teaching this great lesson of Nature. The great civilizations of Rome, Greece and Babylonia, which rose to the highest point of glory and are now non-existent, are illustrations in point. The early history of modern science shows that the great scientists like Galileo and Bruno had, in their search for knowledge, to face insults and suffer tortures at the hands of the blind custodians of religion. The times have changed and the present is an age of steam and electricity. The very section of society, who had done its best to check the development of scientific ideas, is now anxious to verify the principles of its religion in the light of modern investigations.

A word of caution may be sounded at this stage. In order to make a true comparative study of one's religion and the modern science, one should not forget the spirit of the modern scientist. The

present tendency is to distort every fact or religious principle so as to bring it in conformity with the theories of science, without knowing that the theories of science are not absolute truths but are ever changing. The view-point of our study should be to collect those facts to one side which have been verified by the discoveries of science and to put forward boldly before the world those problems which do not agree with the prevalent scientific conceptions and to await solution, if one cannot explain them himself. It is a wrong policy to believe that whatever comes from the West is right; whatever is ours is wrong, although it is true that the westerners make enquiries with impartial views. But since there are limitations to human understanding, the result of enquiries is not always correct.

A present day scientific worker does not work as a Hindu, a Muslim or a Jain. The principle of a particular religion may be confirmed or contradicted by his discoveries, he does not care. He is a meek seeker after truth. Whatever stands the test of sane logic and is verified by experiment is truth in his eyes.

Science may be defined as the "promotion of natural knowledge," "the pursuit of truth," or "the systematic investigation of the world before us" and its claim to be regarded as such is based on the method which it employs for the search of knowledge. The first step is to ascertain the *facts* connected with the problem by experimental investigation, for *Science recognizes no authority other than Nature.* The next step is to *classify the facts*

in order that their significance may be better appreciated. The third essential step is the formulation of a *theory* or *principle* to explain the facts, because science is emphatically not a catalogue of facts but an attempt to fit them into a rational scheme. It is expected of a theory or a principle that it shall be capable of experimental verification and shall lead to a search for new facts. Thus the journey is continued ever onwards into new realms of knowledge. The characteristic feature of this method is that it is constantly in touch with experimental facts and that is why science can justly claim to be the pursuit of truth. But *are the theories of science absolute truths? No, they are not.*

"*Science is a series of approximations to the truth, at no stage do we claim to have reached finality; any theory is liable to revision in the light of new facts*....................This is both the joy and inspiration of science that there appears to be no end to new knowledge with its interest. Each advance yields a more far-reaching and interesting picture of the physical world, while at the same time opening up fresh views in the shape of new problems awaiting solution."*

Leopold Infeld in "*The World in Modern Science*" says:

"Scientific theory is an attempt to form a mental picture of the reality which surrounds us. It may embrace either a narrow or wide range of facts and also experimental laws, bringing them

*A. W. Barton.

into due order. Science is not, however, a collection of laws and a haphazard agglomeration of facts. Theory, to begin with, binds them together with a common idea, and creates a picture of reality from which particular facts follow by a process of logical reasoning.......theory is something more; it is a creative agent, a guide to a land of new and unknown phenomena; it shows how to evolve new systems and to discover new laws. It draws its life blood from experiments which confirm its conclusions. Experiments which conflict with its deductions overthrow and destroy it. Experiment is and will always remain the final court of appeal deciding the fate of a theory.

How do theories arise? How is our mental picture of the world which surrounds us formed and developed? Do we obtain at first a rough sketch, a faint outline, which, as we proceed, gains in clearness and firmness and gathers new and bright colours whilst retaining the stamp and character of the original outline? In other words, is the development of a theory merely a process of evolution, or do there occur cataclysms, great revolutions which in a short space of time transform our whole physical outlook?

In the history of scientific development we discern both these processes—the *evolutionary* and the *revolutionary*. Evolution is the outcome of the collective efforts of generations, of the brilliant successes of illustrious men, and of minor but useful labours which serve to amplify our theoretical ideas; it is the gradual building up of the

structure of science on foundations which have already been laid. In the course of evolution great ideas grow and mature, theory is freed from assumptions, whose extreme simplicity cramps the theory, the range of facts which the theory covers gradually widens and the originally simple mathematical form of the theory becomes at the same time more complicated and far-reaching.

We shall doubtless never succeed in understanding fully the reality which surrounds us. Now-a-days, we are conscious that our feeble efforts and unskilled attempts to grasp the laws of Nature become constantly outstripped by the complexity of the phenomena observed in the world of ours. As a theory develops, there may appear in it some minor flaws which may remain unnoticed in the triumphal progress of the theory, only, however, to manifest themselves more clearly and menacingly later on. Difficulties of this kind, disagreement between deductions from the theory and the results of experiment, *inconsistencies* and *even vital contradictions* which cannot be explained away by the theory—these often contain the seeds of fresh developments by making it necessary to enunciate new principles and to re-lay the foundation of science. *When a theory is frustrated in this manner the ground is prepared for a scientific revolution.* This is nearly the work of one great mind. Such a revolution involves the transfer of problems to a new sphere of investigation, *it forces us to consider the scientific phenomena in a different light,* and it lays a fresh foundation upon which we proceed to build a new and different world of physics."

We give below a typical example to show how the views of science change in time:

"The earth is at rest and the sun moves" was the view of Ptolemy.

"The earth moves and the sun is at rest" was the view advanced by Copernicus. Which of these two statements is correct ?

In answer, again quoting from the same work of Leopold Infeld, p. 18.

"The verdict of classical physics is clear and definite in favour of the second statement (*i. e.*, the Copernican view). Is it perhaps possible, is it conceivable, that both propositions may be false ? And yet a modern physicist, listening to a discussion between supporters of the respective theories of Ptolemy and Copernicus might well be tempted to a sceptical smile. The theory of relativity has introduced a new factor into science and revealed a new aspect of phenomena. *It is now known that the question of deciding between the Copernican view and that of Ptolemy is pointless* and that in fact the proposition of both of them have lost their significance. Whether we say "the earth moves and the sun is at rest" or "the earth is at rest and the sun moves," in either case we are saying something which really conveys nothing. *Copernicus' great discovery is to-day reduced to the modest statement that in certain cases it is more convenient to relate the motion of heavenly bodies to the solar than to the terrestrial system.*"

The reader should carefully note down the latest view-point of science on this ancient puzzle. The Jaina astronomers held the Ptolemaic view with

regard to the relative motion between the earth and the sun and until lately, before the advent of Prof. Einstein's theory of Relativity* the Ptolemaic view

* Prof. Albert Einstein, born in 1879, has been universally regarded as "the brainiest man in the world". He startled the scientists all the world over by his theory of Relativity. The special theory was given in the year 1905 and the general theory of Relativity was published in 1915. One interesting story is told about the explanation of relativity.

Mrs. Einstein did not understand her husband's theories. One day she asked, "What shall I say is Relativity?" The thinker replied with an unexpected parable, "When a man talks to a pretty girl for an hour it seems to him only a minute, but let him sit on a hot stove for only a minute and it is longer than an hour. That is Relativity"

However it is not as simple as that. The theory has brought revolutionary changes in the fundamental concepts of mass, length, time and space, it has supplied a key to the better understanding of the mysteries of the Universe. The size, the mass and the shape of the Universe have been ascertained with the aid of this theory. Here are some of the results

The mass of the Universe=

21430000000000000000000000000000000000000000000000000000gms.

(1 gm. weight= 1 *māshā* (nearly), 931 gms.= 1 Indian seer).

The radius of the Universe -

10100000000000000000000000000 cms. or 1,068 million light-years. 2½ cms.= one inch; light-year is the distance in miles which would be covered by a ray of light in one year at the rate of 186,000 miles per second This number represents the velocity of light. One light-year=586569600,000 miles.

The number of electrons in the Universe=

129000000000000000000000000000000000000000000000000000000
00000000000000000000000 (total number of digits is 80)

(Electron is the tiniest particle of matter discovered by modern science.)

was regarded as absurd and absolutely foolish. Now it has been proclaimed that the conception of motion of the earth round the sun is only a matter of convenience, rather a matter of mathematical convenience.

Denton expressed a similar view in "*Relativity and Commonsense*" :—

"The relative motion of the members of the solar system may be 'explained' on the older geo-centric mode and on the other introduced by Copernicus. *Both are legitimate and give a correct description of the motion* but the Copernican is far the simpler. Around a fixed earth the sun and moon describe almost circular paths but the paths of sun's planets and of their satellites are complex curly lines difficult for the mind to grasp and awkward to deal with in calculation while around a fixed sun the more important paths are almost circular."

Again we notice that the assumption of a fixed earth and the moving sun increases the modern mathematician's difficulties; the calculations become awkward to deal with and hence the Copernican view is preferred, not that the older view is incorrect. It is well to remember in this connection the words of Dr. Schubring, of Hamburg University (Germany), which he spoke on the 30th of January 1928 during the course of a lecture delivered at Delhi:

"He who has a thorough knowledge of the structure of the world cannot but admire the inward logic and harmony of Jain ideas. *Hand in hand with the refined cosmographical ideas goes a high standard of astronomy and mathematics.* A history of Indian astronomy is

not conceivable without the famous 'सूर्य प्रज्ञप्ति' *Surya Pragyapti.*"

What conclusion can be drawn from the brief considerations given above. The answer in the words of Leopold Infeld is "that all theories in physics, like human life, have their beginning and their end. In the twentieth century, with its enormous and intensive developments in science, they enjoy for a time the fullness and joy of life, but their life is short. Our mental picture of the universe is constantly undergoing modification and change. Science is ever giving it a new shape. Science is not a structure in which only the ornamental details of secondary importance are changing. Such a picture of it would be not only sad and dreary, but quite wrong. The joys of creative work and the joys of scientific knowledge and of an appreciation of scientific principles and laws lie in their eternal youth and change. *Change is progress, the road upwards leading through error and mistake.* We change or modify theories in order to bring within their ambit an ever wider range of facts and to obtain an ever greater degree of agreement with observation."

The reader may well note the great contrast between the never changing laws of Nature enunciated by the Jain Tirthankaras and the ever changing theories of modern science. In view of this fact it is never wise to reject what at present seems to be contradictory against the theories of science. The science is ever sounding the bell:

"We are beginning to appreciate better, and more thoroughly, how great is the range of our ignorance."

—*Ibid. Page* 60.

"Truth is what the scientist aims at. He finds nothing at rest, nothing enduring, in the universe. Not everything is knowable, still less is predictable. But the mind of man is capable of grasping and understanding at least a part of Creation;"

—*The Restless Universe by Max Born, Page* 278.

Then there is another important feature introduced in Science by the great Theory of Relativity. Einstein has very beautifully differentiated between 'true' and 'really true'. To quote his own words—

"Is it really true that a moving rod becomes shortened in the direction of its motion? It is not altogether easy to give a plain answer. I think we often draw a distinction between what is *true* and what is *really true*. A statement which does not profess to deal with anything except appearances may be *true*;* a statement which is not only true but deals with the realities beneath the appearances is *really true*."

According to Einstein, we can know the truth. but not the real truth or absolute truth. The following illustration taken from the domain of physics will make the point clear :—

Imagine a stationary conductor charged with electricity placed anywhere upon the surface of the earth. There exists an electric field round a charged conductor. In other words, it means that if any other conductor charged with electricity is brought in the neighbourhood of the former the latter will

*In the terminology of Jaina Scriptures 'True' refers to व्यवहार सत्य (Vyavahar Satya) and 'Really True' refers to निश्चयात्मक सत्य (Nishchayatmak Satya).

be attracted or repelled* depending upon whether it is charged with the opposite kind of electricity or of the same kind. It is well to bear in mind that there is no magnetic field round a stationary electric charge, *i. e.*, a magnetic compass brought in its neighbourhood would not be deflected by it. But as the earth is in motion round its axis, to an observer situated on a distant planet, the conductor which is stationary *relative* to the earth, will appear to be in motion. Now we have just said that there is no magnetic field round a stationary electric charge but a charge in motion always gives rise to a magnetic field. (See adjoining figure) So if the distant observer were to make his measurements on the terrestrial conductor he would find the presence of the magnetic field It means there is no magnetic field round the conductor relative to the observer on the earth but there is a magnetic field round the same conductor with respect to the stellar observer. We arrive at the strange conclusion that the charged conductor is giving rise to and not giving rise to a magnetic field at the same time. What is the absolute truth ? Is there a magnetic field round the conductor or is there none ? No answer can be given to this question. Einstein says, "We can only know the relative truth,

A represents a metal sphere charged with electricity. The arrow indicates its motion. Since moving charge is a sort of electric current, it is shown surrounded by lines of magnetic force.

*There are two kinds of electric charges, called the positive and the negative, and the rule is :

Two bodies charged with the same kind of electricity repel each other while unlike charges attract each other.

the Real Truth is known only to the Universal Observer." Universal Observer of Einstein is none else but the Almighty सर्वज्ञ देव (Sarvagya Deva) with infinite powers of knowledge and bliss.

According to Einstein, even the measurement of Space and Time is relative. Says Eddington in the "*Nature of the Physical World*":

"A fast moving traveller lives more slowly. His cycle of digestion and fatigue; the development of his body from youth to age; the watch which ticks in his waistcoat pocket; all these must be slowed down in the same ratio. If the speed of his travel is very great, we may find that, whilst the stay-at-home individual has aged 70 years, the traveller has aged one year."

This probably furnishes an explanation of the long age of thousands of years enjoyed by Devas* and of the long durations after which hunger is excited within them. It is quite possible that the Vimàns (aeroplanes) in which they live and move are moving with tremendous velocities relatively to us.

Thus we see that the truth investigated by science is relative and not absolute and its theories are ever liable to change. The reader might well

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*Judge, J. L. Jaini, in the "*Jaina Hostel Magazine*" Vol. VII, Number 3, page 10 has observed that there is a fixed proportion between the respiration, feeling of hunger and the age of the celestial beings. The food interval is 1,000 years and the respiration one fortnight for every Ságar of age. The proportion of food interval to respiration is thus, 1 to 24000. He has further observed that if a man lived like a god, we should have a legitimate feeling of hunger only once in the day. A normal person has 18 respirations to the minute, or $18 \times 60 \times 24 = 25920$ in 24 hours, roughly 24,000.

ask: "What is the value of science if it does not reveal the reality which surrounds us? How are we to discern, through ever-changing theory, the true outline of the world in which we live?" Remember that science has failed to answer these questions. Again in the words of Leopold Infeld, "What is the use of introducing these great questions of metaphysics into the sphere in which we are only just beginning to appreciate the immense complexity of what are seemingly the simplest phenomena of nature?"

Once again we apprise the reader not to forget the words of Prof. Infeld:

"Scientific theories arise, develop and perish. They have their span of life, with its successes and triumphs, only to give way later to new ideas and a new outlook"—p. 231.

As said Sir Rabindranath Tagore, winner of the Nobel Prize, "Until I had received an honour from a foreign country, I had received scant admiration from my countrymen", so we may say, "Until an ancient view receives recognition from a foreign country, it receives scant admiration from its countrymen." This spirit should die and the time is come when we should prove by our independent work the truth of our convictions. The author will consider his life-long labours amply repaid if he succeeds, in some measure, in establishing to demonstration that this is so, by publishing this commentary on the 5th Chapter of Tattwarthadhigama Sutra by Sri Acharya Umaswami, also called Uma Swati, comprising only 42 aphorisms in Sanskrit, covering hardly a page of this book.

॥ श्री जिनेन्द्राय नमः ॥

तत्वार्थधिगम सूत्रे पञ्चमोऽध्यायः ॥

अजीव काया धर्माधर्माकाश पुद्गलाः ॥१॥

(Ajiva Kaya dharmadharmakasha pudgalah.)

This Sutra has got the same version in Digambar and Swetambar texts.

The substances of the universe may be divided into two chief categories: Living and Non-living; or Soul and Non-soul.

The Non-living continuum comprises of
धर्म (Dharma)—Medium of motion for soul and matter.
अधर्म (Adharma)—Medium of rest for soul and matter.
आकाश (Akasha)—Space and
पुद्गल (Pudgala)—Matter and Energy, and
काल(Kala)—Time (*enumerated separately in Sutra* 39.)

In all Jain Scriptures dealing with the subject there is a description of these substances. We have in *Dravya-Samgraha* by Nemichandra* Siddhanta-Chakravarti:

अजीवः पुनः ज्ञेयः पुद्गलः धर्मः अधर्मः आकाशम् ।
कालः पुद्गलः मूर्त्तः रूपादि गुणः अमूर्तयः शेषाः तु ॥ १५ ॥

—*Sanskrit rendering of Prakrit Gatha.*

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*Nemichandra was a great Acharya who lived in the tenth Century A. D. He was the preceptor of Raja Chamund Rai of Ganga Dynasty of South India and has composed several standard works like गोमटसार, त्रिलोकसार, लब्धिसार, क्षपणसार, and द्रव्यसंग्रह ।

(Ajiva comprises of Pudgala, Dharma, Adharma, Akásha and Kála. Pudgala has form and qualities and the rest are without form.)

Panchastikaya of Shri Kundkundacharya gives the following :—

जीवा पुग्गलकाया धम्माधम्मा तहेव आयासं ॥ ४ ॥

(जीवाः पुद्गल काया धर्माधर्मौ तथैव आकाशम्)

Canto I, 4.

(Jivas or souls, Pudgala or matter, Dharma and Adharma, the media of motion and rest and finally Space) are called Astikayas.

To quote the same principle from other Digambar Jain works:

धर्माधर्मौ नभः कालः पुद्गलश्चेति पञ्चधा ।
अजीवः कथ्यते सम्यग् जिनैस्तत्त्वार्थ दार्शिभिः ॥ ८१ ॥

—धर्माशर्माभ्युदय काव्य अ० २१

or धर्माधर्मावथाकाशं कालः पुद्गल इत्यपि ।
अजीवः पञ्चधा ज्ञेयो जिनागम विशारदैः ॥ ६७ ॥

—चन्द्रप्रभः चरित काव्य, अ० १८

or अथ पुद्गल एवात्र धर्मोऽधर्मो द्विधा नभः ।
कालश्च पञ्चधैवेत्य जीवतत्त्वं जगोजिनः ॥ १५ ॥

—वर्धमान पुराण, भट्टारक सकलकीर्तिकृत, अ० १६

(Lord Jina has described five kinds of Ajiva, *viz.*, Pudgala, Dharma, Adharma, Akásha, and Kála).

Also from Swetambar Agam we have the following :—

चत्तारि अत्थिकाया अजीवकाया पण्णत्ता, तंजहा-धम्मत्थिकाए, अधम्मत्थिकाए, आगासत्थिकाए, पोग्गलत्थिकाए।

स्थानांग स्थान ४ उद्दे० १ सूत्र २५१
व्याख्या प्रज्ञप्ति शतक ७ उद्दे० १० सूत्र ३०५

(Amongst the non-living Astikayas there are four, Dharma, Ȧdharma, Akásha and Pudgala.)

Commentary.

अजीव काया—यथा शरीरं पुद्गल द्रव्य प्रचयात्मकं तथा धर्मादिष्वपि प्रदेश प्रचया पेक्षया काया इव काया इति। अजीवाश्च ते कायाश्च अजीव काया।

—श्री पूज्यपादकृत सर्वार्थसिद्धि.

Just as the body of any living-being is a conglomeration of matter, in the same way the substances Dharma, Adharma, Akásha and Pudgala are a conglomeration of Pradeshas (प्रदेश) and may, in this light, be looked upon as possessing body(काया). Hence substances which are non-living and have Kaya (काया) are called Ajivakaya.

अस्तिकाय (*Astikaya*).—*Asti* means 'exists' and *kaya* means body. Hence an Astikaya is a substance which has characteristics of existence as well as a body composed of Pradeshas. The substance Kála (Time), though having the characteristic of existence, is not included amongst the Astikayas because it does not have many Pradeshas. Astikayas are five: Jiva, Ajiva, Dharma, Adharma and

Akásha and these together with Kala constitute the Six Realities of Jain philosophy.

प्रदेश—(Pradesh)

यावन्मात्रं आकाशं अविभागि पुद्गलाण्ववष्टब्धम् ।
तं खलु प्रदेशं जानीहि सर्वाणुस्थान दानार्हम ।। २७ ।।

—**द्रव्यसंग्रह, प्राकृत गाथा की संस्कृत छाया.**

(Pradesha is the unit of space occupied by one indivisible atom of matter and capable of being occupied by other fundamental particles.)

In other words, Pradesha is that tiny portion of Akásha which one indivisible ultimate atom of matter occupies. In such a Pradesh of Lokákásha one Pradesha of Dharma, one Pradesha of Adharma, one particle of Kála and *innumerable atoms of matter or even molecules in a subtle state* may exist.

It is quite reasonable to ask how can an innumerable number of atoms occupy one unit of space when the unit of space has been defined as the portion of space occupied by a single atom. It is an apparent contradiction in terms. Before we try to explain this beautiful anomaly, let us produce from other sources evidences to corroborate the same view.

Shri Acharya Pujyapada writes in the **सर्वार्थसिद्धि** (*Sarvarthasiddhi*) as follows:—

परमाणुः स यावति व्यवतिष्ठते स प्रदेश इति व्यवह्रियते ॥

It is an assumption that the space occupied by an indivisible particle of matter is called Pradesha. (It is a convenient assumption because truly speaking space is a continuous medium but it is broken

up into Pradeshas for explaining physical phenomena).

Further on the same author says:

स्यादेतद संख्यात प्रदेशो लोकः अनन्त प्रदेशस्या नन्तानन्त प्रदेशस्य च स्कन्धस्याधिकरण मिति विरोधस्ततो नानन्त्य मिति ॥ नैष दोषः । सूक्ष्म परिणामवगाहन शक्ति योगात्परमाण्वादयो हि सूक्ष्म भावेन परिणता एकैकस्मिन्नप्याकाश प्रदेशेऽनन्तानन्ता नाम व स्थानं न विरुध्यते ॥

(How can an infinite number of atoms and molecules—multiple-atomed molecules some of which are comprised of an infinite number of atoms—be accommodated in space where the number of Pradeshas is only innumerable* and not infinite?)

This is the same question which we have raised, worded, of course, in a different language and the author replies, न एष दोषः (it is no contradiction). How? सूक्ष्म-परिणाम-अवगाहन शक्ति-योगात् (On account of the subtlety and accommodating power of molecules).

In order to appreciate fully the subtleties of atoms and molecules we shall have to dive deep into the discoveries of modern atomic physics. Before we begin consideration of the model of an

*Jainism draws a distinction between innumerable and infinite. The former has a limit though it is beyond the power of even an omniscient being to count them, the latter is without limit.

"संख्याविशेषातीतत्वादसंख्येयाः"

"तदनुपलब्धेर सर्वज्ञत्व प्रसंग इति चेन्न तेनात्मनावसितत्वात्"

—तत्वार्थ राजवार्तिक ।५।८।१।३

atom as conceived by Sir Rutherford, who has been rightly given the name, "Father of Modern Atom", we shall give a brief historical sketch.

"Truth was originally implanted in mankind, but having been suffered gradually to slumber, it was finally forgotten. Since that period, knowledge returns to us as a recollection."—*Lord Krishna.*

Although the western scholars have no faith in the above doctrine of Indian Krishna, it is nevertheless a historic fact based on philological* evidences that Aryan culture of the East is the most primitive culture known on the surface of the earth. According to the investigations of western scholars Aristotle and Kant who, at one time, swayed philosophic thought most powerfully, taught that the space in the Universe is *continually filled* with matter. The first clear exposition of the fact that matter is not continuous but atomic is said to have been given by the Indian Rishi Kanada† long before the rise of Grecian philosophy. Amongst the Greek philosophers, Democritus of Abdera was the first to put forth the opinion that the world consists of empty space and an infinite number of indivisible, invisibly small atoms and that the appearance and disappearance of bodies was due to the union and separation of atoms. It is well to bear in mind that Democritus lived about the year

*Vide O. Schrader, Sprachvergleichungen und Urgeschichte, Jena, 1907, T. Taylor, The Origin of the Aryans, London, 1892; F. M. Muller, Biographies of Words, and the Home of the Aryas, London, 252, 1888.

†H. T. Colebrooke, Asiatic Researches of Calcutta, 5.1, 1799.

420 B. C., when the beautiful realities of the atomic world revealed by Lord* Mahavir were hardly 100 years old. "According to Max Muller, there are many points in common between the early Greek and Indian philosophers, and there is a *historical possibility* that the Greeks were influenced by Indian thought travelling through Persia."†

It is rather unfortunate that Jainas until lately did not give opportunity to western scholars to study their literature,‡ otherwise the history of atomic theory of matter would have well extended beyond the time of Kanada and Grecian philosophers to the time of Lord Parsvanath, (842 B. C.), if not beyond it. (Western scholars have come to regard Lord Parsvanath as a historical person and founder of Jainism. See *History of the World* by Harmsworth, Vol. II, p. 1198). The main difficulty in tracing the ancient origin of any fact mentioned in Jain Scriptures lies in the fact that the usage of committing to paper was unknown in days of old, the knowledge being transmitted from the teacher to the pupil or from the father to the son orally. The earliest written Digambar Jain works are those of Shri Kundkundacharya (about 100 A. D.) about which it is sometimes said that, although

*Lord Mahavir (598-526 B. C.).

†Quoted from "A Comprehensive Treatise on Inorganic and Theoretical Chemistry" by J. W. Mellor, D. Sc., p. 22.

‡ "Some day when the whole of the Jain Scriptures will have been critically edited and their contents lexically tabulated together with their ancient glosses, they will throw many lights on the dark places of ancient and modern Indian languages and literature."—Dr. Barnett.

based on the word of Lord Mahavir, it is not the Shrut literature of his times. The Shrut literature was organized and written down by Swetambar saints in the fifth century A. D.

We have referred above to the discovery of atomic nature of matter by Democritus. His views may be summarized as follows :*

1 Matter is discrete, not a continuum. (*Compare it with* अणव स्कन्धाश्च ॥ तत्वार्थसूत्र ५, २५ ॥ (matter is in the form of atoms and molecules.).

2. All substances are formed of solid atoms which are separated from one another by void space. Each atom is a distinct individual.

3 The atoms are impenetrable, indivisible, and indestructible. They are as perfect, as fresh to-day as when the world was new.

4. The atoms differ from one another in shape, size and weight.

5 There is a finite number of different kinds of atoms, but an infinite number of homœmetric (of like shape) atoms of each kind.

Compare with संख्येयाऽसंख्येयाश्च पुद्गलानाम ॥ तत्वार्थसूत्र, ५, १०.

6. The properties of all substances depend upon the nature of the constituent atoms and the way the atoms are arranged.

7 The atoms are in constant motion.

8. Combination or aggregation is due to the coalescence of moving particles.

Compare this with: भेदसन्घातेभ्यः उत्पद्यन्ते ॥ तत्वार्थसूत्र ५, २६ ॥

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*Quoted from "Comprehensive Treatise on Inorganic and Theoretical Chemistry"—J. W. Mellor.

The name of John Dalton (1766-1844) is closely associated with the development of Atomic Theory of Matter in Europe. He was an English chemist, who in 1803 definitely declared that a gas such as air, oxygen, nitrogen, etc , was composed of discrete particles which were in rapid movement and that the size of the particles was small compared to their distances apart.

Modern investigations have shewn conclusively that all matter is composed of molecules which, in the case of gases, are travelling in all directions with high speed. Theoretically a piece of chalk may be broken into two pieces, those two into four, and so on to infinity. In reality, matter cannot be sub-divided beyond a certain point without losing its identity. The smallest particle into which matter may be subdivided without destroying its characteristic properties is called a *molecule* (**स्कंध**). *

The Skandha (**स्कंध**) is described as follows in *Panchastikaya Sar* :—

स्कन्धाश्च स्कन्धदेशाः स्कन्ध प्रदेशाश्च भवन्ति परमाणवः
इति ते चतुर्विकल्पाः पुद्गलकाया ज्ञातव्याः ॥ ८० ॥

स्कन्धः सकल समस्तस्तस्य त्वर्धं भणन्ति देश इति ।
अर्द्धार्द्धं च प्रदेशः परमाणुश्चैवाविभागी ॥ ८१ ॥

–Sanskrit rendering of Prakrit Gathas.

(Matter exists in four main forms : **स्कंध**, **स्कंधदेश**, **स्कधप्रदेश** and **परमाणु**।

*In the Nyaya and Visheshika schools of Hindu philosophy also the theory of the atomic structure of matter is found well developed.

The complete molecule of matter is Skandha; a half of it is Skandhdesh; a half of that half is Skandhpradesh; and what cannot be divided is the primary atom.)

No one has ever seen a molecule: these particles being so small that even the best microscope fails to reveal them. The diameter of a molecule has been measured to be one ten-millionth of an inch ($\frac{1}{100,000,00}$ in.) A drop of water is about one-eighth of an inch ($\frac{1}{8}$ in.). If it is enlarged five crore times such that its diameter is nearly a hundred miles, the molecules of water within it would appear to have one inch diameter and if the drop were magnified to the size of the earth, the molecules in it would appear about the size of oranges.

The velocity of molecules in a gas varies from one to seven miles per second, while it should be remembered that the velocity of a rifle bullet seldom exceeds half a mile per second. Seven miles per second is such a high velocity that if a body be projected with this velocity from the surface of the earth, it would go beyond the earth's attraction and would never return.

By indirect methods it has been learnt that one cubic inch of air contains 442400000000000000000 molecules. It has been estimated by Prof. Andrade* that the number of molecules in one ounce of water is so great that 'if every man, woman and child in the world were turned to counting them and counted fast, say five a second, day and night, it would take about 4 million (4000000) years to complete the job'.

**The Mechanism of Nature* by E. N. da C. Andrade, D. Sc., Ph. D., p. 37.

Although the molecules are so very small, they are not relatively near neighbours; the space between them is much greater than that occupied by the molecules themselves. Within the solids the molecules oscillate to and fro about a mean position. In the liquids they are more free to move and in the gases the agitation is very great. For instance the separation of molecules in steam is about twelve times greater than in liquid water. On account of this greater freedom in gases, the molecules are constantly colliding one against the other, the number of collisions per second being about 6,000 million. *i. e.*, 6,00,00,00,000 times per second. The mean distance travelled between successive collisions has been estimated to be three-millionths $\left(\frac{3}{1,000,000}\right)$ of an inch.

This is the picture of the hurly-burly tumultous dance of molecules within a gas. We shall start to explore the interior of a molecule now. In a molecule of common salt (See Fig. 1) there are two atoms, one of sodium and the other of chlorine but in a complex molecule like that of alum the number of atoms is about hundred.

O Sodium Atom ● Chlorine Atom
A crystal of common Salt (NaCl)

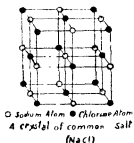



Fig. 1.

According to the Jaina view, the material atoms have the capacity of compressing an infinite number of themselves into one molecule. We shall presently bring forth the evidence of modern science in confirmation of this view.

When a gas is heated, the molecules within it rush about more vigorously and if the temperature is

sufficiently raised, the molecules begin to fall to pieces, *i. e.*, the atoms composing them get separated out just as a cluster of balls glued together would break up under hard impact.

The older view with regard to the atom was that it is a "billiard-ball"—like thing, hard, unbreakable, indestructible and of the same nature all through, like a jelly but this conception of atom was revised by Sir Rutherford According to him the interior of the atom is a solar system, *i. e.*, an atom is not solid like a billiard-ball but highly porous like the solar system. From a series of difficult experiments Rutherford came to the conclusion that an atom contains within its centre a massive charge of positive electricity*, with a number of negative electricity particles, called electrons, going round the former with very great velocities in fixed orbits like the planets round the sun The specifications for the hydrogen atom are given below. The positive charge in the centre is called the proton. See Fig. 2 on p. 14

Hydrogen atom.

Diameter	..	$\left(\frac{1}{200,000,000}\right)$ inch.
Weight	..	$\frac{164}{100,000,000\ 000,000,000,000\ 000,0}$ gram

*See foot-note on p. xii of the Prologue.

When a dry vulcanite fountain-pen is rubbed with a silken handkerchief, it is observed that rubbed bodies acquire the property of attracting light bodies such as scraps of paper or small feathers. They are said to be charged with electricity. It would be noted that the vulcanite becomes charged with one kind of electricity and silk with the other kind These two kinds are called arbitrarily as positive and negative.

Electron.

Diameter	..	$\frac{1}{500,000,000,000,0}$ inch.
Speed	..	1,300 miles per second.
Weight	..	$\frac{1}{2,000}$ of the weight of the hydrogen atom.

Proton.

Diameter	..	About ten times that of the electron.
Weight	..	that of the hydrogen atom.

The central positive charge of electricity, the *nucleus*, has a diameter only about a ten-thousandth of that of the atom and practically all the mass of the atom rasides in it The diameter of an atom is one part out of twenty crore parts of an inch. The lightest atom is that of hydrogen* having a mass only one-quadrillionth (1 followed by 24 cipher) part of one máshá (gramme) while the mass of an electron is even two-thousandth part of this. The diameter of an electron is five-billionth (1 followed by 12 ciphers is a billion) part of an inch which is about 2,500-millionth (२ अरब ५० करोड़वां भाग) part of the diameter of human hair. In an eight-mile molecule the electrons are only 8 inches in diameter. These electrons revolve round the nucleus† several quadrillion times per second with a speed of 1,300 miles per second. All these figures tend to show that matter is extremely porous. *This porosity of matter was clearly understood by the Jain thinkers*

*Hydrogen is the gas which is evolved by dissolving zinc in sulphuric acid and on account of its lightness is used in filling toy balloons and also bigger ones. Water is a compound of hydrogen and oxygen.

†The concentrated electric charge in the centre of an atom is called the nucleus.

several centuries before the Christian era. It is this fact which is expressed by words सूक्ष्म परिणाम अवगाहन शक्ति (subtlety and accommodating power of the molecules). (See p. 5). It is interesting to quote in this connection the words of Prof. Eddington, the great Astronomer Royal at Cambridge. He says : "If we eliminate all the unfilled space in a man's body and collect the nucleii and electrons into one mass, the man would be reduced to a speck just visible with a magnifying glass."

In order to understand fully how innumerable atoms of matter may be compressed in one unit of space (प्रदेश) (*vide* p. 4), let us proceed a little further and look into the constitutions of atoms as revealed by modern science.

The positive charge of electricity in the centre of the hydrogen atom is called the proton and there is only one electron revolving about this proton in a circular orbit of one 25 millionth part of an inch. (See Fig. 2.) In the same way an atom of helium gas contains two protons in the centre and two electrons moving round the central nucleus*. Then there are atoms with three protons in the centre and three electrons going round and so on, until in the heaviest atom

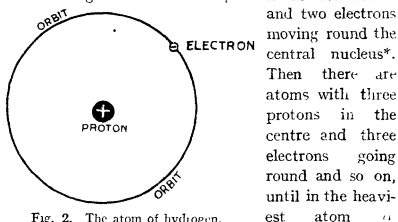
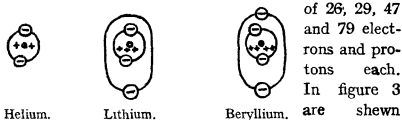



Fig. 2. The atom of hydrogen.

*The nucleus of an atom may consist of one or more number of protons.

uranium metal there are 92 protons in the centre and 92 electrons going round them in different orbits. In each case the number of protons is equal to the number of electrons. The atoms of iron, copper, silver, and gold consist, respectively, of 26, 29, 47 and 79 electrons and protons each. In figure 3 are shewn atoms of helium, lithium and beryllium. The sign + refers to the proton and the sign — refers to the electron.

Helium.

Lithium.

Beryllium.

Fig. 3.

The great variety of matter in the universe depends on the fitting together of 92 kinds of atoms to form all manner of structures. These 92 different kinds of atoms consist of 92 different nuoleii with corresponding swarms of electrons.

We have just mentioned on page 12 that on sufficient heating the molecules of matter get broken up into the constituent atoms. The question next arises as to what happens when an atom or atoms are continuously heated to a very high temperature. The temperature within the interior of certain stars is very high, the highest temperature estimated by Eddington being about four crore degrees Centigrade. What would be the state of atoms inside these stars? At these high temperatures the atoms begin to lose their outer electrons, *i. e.*, the electrons which compose the body of the atom begin to separate from the atom. Such atoms, in the language of science, are called "ionised" atoms, and the

process of separation of the electrons from the atom is called "ionisation". In some case it happens that atoms lose entirely their rings of electrons, the atoms are then called 'stripped' atoms. The theory of stripped atoms has found a beautiful confirmation in the following important and curious astronomical discovery.

Sirius (लुब्धक), which is the brightest star in the heavens, has got a dark companion ten thousand times fainter than itself which was discovered in 1845 by Alvan Clark. From calculations the mass of the dark companion was found to be one-fourth of Sirius, or $\frac{3}{4}$ of the sun. It has a diameter 1/30 of the solar diameter and surface temperature 9000 degrees, while the surface temperature of the sun is only 6000 degrees Centigrade. A simple calculation shows that the material of which this star is composed is 2000 times more heavy than the heaviest metal known on earth. An ordinary layman thinks that either gold, mercury, lead or platinum is the heaviest metal. It is true that platinum is the densest metal known on earth but have you ever dreamt that there is somewhere in the universe a metal 2000 times denser than platinum and as to how could it have been formed? What must be the peculiarity associated with the atoms of which it is composed? Prof. M. N. Saha, D. Sc, F. R. S., in his Presidential Address delivered before the Science Congress, Bombay, in 1926, says, "It is apparent that the star consists only of stripped atoms, that is to say, of atoms which have lost some of their outer rings of electrons. This must be due to the high temperature prevailing in the star, but *it is*

not at all clear how stripped atoms with a large excess of positive electricity can be so closely packed;* because as the charges are of the same sign, the tendency would be for infinite dispersion, instead of abnormal condensation. But such cases of abnormal condensation are not altogether unknown in Physics. The nucleus of atoms consists of a large excess of positive charges *which are somehow packed within a very, very small compass.*"

The last words of the renowned physicist Dr. Saha mean nothing but that an ***innumerable number of atoms in a subtle state can occupy one unit of space*** (*Pradesh*). This was the teaching of the Tirthankaràs centuries before the advent of modern science.

With regard to this kind of matter, Eddington wrote a few years ago, "One ton (=28 maunds) of such nuclear matter can be easily carried in a waistcoat pocket." But now comes the news that matter even more dense than this has been discovered. Ruby Ta'Bois, F. R. A. S., writing in "Arm Chair Science," London, July 1937, says :

"In some of these bodies (small stars) the matter has become so densely packed that a cubic inch weighs a ton. The smallest known star discovered recently is so dense that a cubic inch of its material weighs 620 tons ! "

A piece of matter one inch long, one inch broad, one inch thick has a weight over 17,000 maunds !! Can you dream it ? Can you believe it ? Nevertheless it is a fact. It is the result of सूक्ष्म परिणाम

*See Foot-note on page xii of the Prologue.

अवगाहन शक्ति that an innumerable atoms of matter can occupy one Pradesh. Modern sceptic thinks 'and wonders whether the phenomenon of packing of stripped atoms was known to ancients. However the fact is there. The definition of Pradesh is full of significance. We reproduce it once more:

"Pradesh is the unit of space occupied by one indivisible atom of matter but in which innumerable atoms of matter may exist in a subtle state."

Now we take up the discussion of the next component धर्म (Dharma) in the main Sutra:

अजीव काया धर्माधर्माकाश पुद्गलाः ॥ १ ॥

धर्म (Dharma) has been defined by the Jain writers in the following terms :—

"गमण णिमित्तं धम्मम्"

(The auxiliary cause of motion is Dharma.)

--नियमसार, श्रीकुन्दकुन्द विरचित ॥२,३०॥

गति परिणतानां धर्म्मः पुद्गल जीवानां गमन सहकारी ।
तोयं यथा मत्स्यानां अगच्छतां नव स नयति ॥ १७ ॥

—संस्कृत छाया, द्रव्यसंग्रह.

(As water helps the movement of a moving fish so does the medium of Dharma help the motion of matter and soul. But it does not move those which are not moving.)

It should be noted that the word Dharma* has

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*"धर्मादयः संज्ञा सामायिक्यः ।
आर्हते हि प्रवचनेऽनाधिनिधिनेऽर्हदादिभिः यथाकालं, अभिव्यक्त ज्ञानदर्शनातिशय प्रकाशैरव द्योतितार्थ सारे रूढा एता संज्ञा ज्ञेयाः । किया निमित्ता वा ।"

—तत्वार्थं राजवार्तिकम् ।५।१।१७।१८।

been used in entirely a different technical sense than it is ordinarily understood to mean. Hindu philosophers have used the word in the sense of 'duty' or "righteous deeds" but according to the Jain writers (दधातीति धर्मः). "Dharma" means the Aether of Space, the medium of motion, peculiar although it may seem.

"जीव पुद्गलयोर्धर्म्मः सहकारी गतेर्म्मतः ।
अमूर्त्तो निष्क्रियो नित्यो मत्स्यानां जलवद् भुवि ॥"

—सकलकीर्ति कृत वर्द्धमान पुराण ॥ १६, २९ ॥

(Dharma is known to assist the motion of soul and matter. It is formless, inactive and eternal. It behaves like water towards the fish in the world.)

"क्रिया परिणतानां यः स्वयमेव क्रियावताम् ।
आदधाति सहायत्वं स धर्म्मः परिगीयते ॥ ३३ ॥
जीवानां पुद्गलानां च कर्त्तव्ये गत्युपग्रहे ।
जलवन्मत्स्य गमने धर्म्मः साधारणाश्रयः ॥ ३४ ॥"

—अमृतचंद्र सूरि कृत तत्वार्थसार, अध्याय ३ ।

(The medium, which helps the motion of things already in motion, is called Dharma. Just as a fish takes the help of water in its movements so do soul and matter take the help of Dharma when they begin to move by themselves.)

"धर्म्मः स तात्विकैरुक्तो यो भवेद् गतिकारणम् ।
जीवादीनां पदार्थानां मत्स्यानामुदकं यथा ॥"

—धर्मशर्माभ्युदय काव्य ॥ २१, ८३ ॥

(The fulcrum of motion for substances like soul, etc, is called Dharma by the adepts.)

"जलवन्मत्स्ययानस्य तत्र यो गति कारणम् ।
जीवादीनां पदार्थानां स धर्म्मः परिवर्णितः ॥ ६९ ॥
लोकाकाशमभिव्याप्य संस्थितो मूर्तिवर्ज्जितः ।
नित्यावस्थिति संयुक्तः सर्वज्ञ ज्ञान गोचरः ॥ ७० ॥"

—चन्द्रप्रभु चरितम् ॥ १८ अ० ॥

(That which is the cause of motion of substances like souls is Dharma. It helps motion just as water helps the motion of a fish. It pervades the whole universe (लोकाकाश), is without form and eternal and its true nature is known only to the omniscient".

In *Panchastikaya Sar* of Shri Kundakunda we have the following detailed description of Dharmastikaya:—

धर्मास्तिकायोऽरसोऽवर्णगन्धोऽशब्दोऽस्पर्शः ।
लोकावगाढः स्पृष्टः पृथुलो ऽ असंख्यात प्रदेशः ॥ ९० ॥
अगुरुलघुकैः सदातैः अनन्तः परिणतः नित्यः ।
गति क्रियायुक्तानां कारणभूतः स्वयम कार्यः ॥ ९१ ॥
उदकं यथा मत्स्यानां गमनानुग्रहकरं भवतिलोके ।
तथा जीव पुद्गलानां धर्मद्रव्यं विजानीहि ॥ ९२ ॥
जातमलोकलोकं ययोः सद्भावतश्च गमनस्थितिः ।
द्वावपि च मतौ विभक्तावविभक्तौ लोकमात्रौ च ॥ ९४ ॥
न च गच्छति धर्मास्तिको गमनं न करोत्यन्यद्रव्यस्य ।
भवति गतेः सः प्रसरो जीवानां पुद्गलानां च ॥ ९५ ॥
विद्यते येषां गमन पुनस्तेषामेव सम्भवति ।
तेस्वक परिणामैस्तु गमनं स्थानं च कुर्वन्ति ॥ ९६ ॥

—*Sanskrit rendering of Prakrit Gathas.*

(Dharmastikaya being a non-corporeal (अमूर्त) substance has none of the qualities ordinarily associated with matter, *i. e.*, it is devoid of qualities of contact, taste, colour, smell, and sound. It is a *continuous medium* pervading the whole universe (लोक). Although, truly speaking, it is non-atomic in nature, *i. e.*, without grains in its structure, for purposes of practical convenience, it is regarded as made up of a number of units of space, *i. e.*, Pradeshas.

It undergoes an infinite number of modifications of an incorporeal nature* and has the characteristic property of persistence through births and deaths, hence it is a real and permanent substance. It remains unchanged by the motion of objects but it conditions the motion of those that can move, matter and life.

Exactly as water is indifferent to the movement of fishes, so is the Dharma Dravya, itself non-motive, the *sine qua non* of motion of souls and matter.

Dharma and Adharma are the substances with the help of which we can distinguish between the finite universe and the void beyond it; these media condition the motion and the state of rest of the bodies. They are uncreated (like Space, Time and Matter) and are co-extensive with Lokàkàsha (Universe).

Dharmastikàya neither moves by itself nor creates motion in other things but it supplies the necessary means for the motion of living and non-living bodies.)

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*For these modifications read commentary on Sutra 7.

The attributes of Dharmastikàya are given in Swetambar Sutras as *follows* :—

धम्मत्थिकाए णं जीवाणं आगमण गमणभासुम्मे समण जोगा वइजोगा कायजोगा जे यावन्ने तहप्पगारा चला भावा सव्वे ते धम्मत्थिकाए पवत्तंति। गइलक्खणे णं धम्मत्थिकाए।

—व्याख्या प्रज्ञप्ति शतक १३ उ० ४ सू० ४८१.

धम्माधम्मे य दो चैव, लोगमित्ता विया हिया ।
लोगालोगे य आगासे, समए समय खेत्तिए ॥

—उत्तराध्ययन सूत्र, अध्या० २८, गाथा ७.

The Jaina point of view with regard to the media of motion and rest (धर्म and अधर्म) is well summarized by Prof. A. Chakravartınayanar, M. A., L. T., Presidency College, Madras, in his English commentary on *Panchastikaya*. We quote the following from page 96 :—

"Motion and rest contemplated in this connection are distinctly physico-mathematical. They should not therefore be interpreted even metaphorically to mean anything more than that connotation. We have to remember the following points :—

1. Dharma and Adharma are Amurta Dravyàs. They have no sense qualities of colour, etc.
2. They are Ajivàs—non-living.
3. They have spatial relation though in themselves Eka-pradeshi (एक-प्रदेशी).
4. They are Nishkriyas—non-active.
5. They are Bahiranga hetu (बहिरंग हेतु) or Udasina hetu (उदासीन हेतु) and not Mukhya hetu (मुख्य हेतु).

6. They are non-discrete and continuous.

These are some of the important common qualities emphasised by the Jain thinkers.

The Jain philosopher recognized in the world matter, life and space. But are they enough? No. *There would be no world. The Atoms and Jivás may be scattered throughout the infinite space.* Therefore there must be something else besides these three. That something must be able to maintain a coherent system of Jivás and atoms, must have the function of preventing the atoms, from flying about, must limit the boundary of the world of things and persons. For the author distinctly says that without Adharma there would be only chaos; there would be no world. Therefore the Jain thinkers pointed the existence of a fourth entity which binds together things and persons. So the hypothesis of Adharma.

This is something like Newton's gravitation; but Adharma is slightly different. Its main function is to arrest things and but then there is one difficulty. If there were Adharma alone how could there be motion at all in all things? There would be an eternal paralysis of Reality. To remove this difficulty Dharma had to be posited. The function of Dharma is to guarantee motion within the limits imposed by Adharma. This is the reason for the second hypothesis.

But the trouble is not yet over. If the two exist within a spatial limit one guaranteeing motion and the other rest, then the things in motion must be in motion for ever and things at rest must be

there for ever.* But our experience is not of that kind. One and the same body has motion or rest; it may move or it may come to stay. Therefore Dharma and Adharma must be deprived of their causality. They can only be Bahirang-hetu or Udásina-hetu, *i. e*, they must be indifferent and neutral in themselves and yet must be indispensable to the composition of the world.

This seems to be the logical development of the system. The most approximate modern conception answering to the description will be Ether of the physicist. But the Jaina systems require two such entities functionally different; one acting like Newton's gravitation (Adharma) and the other guaranteeing motion within the limits. It would not be quite accurate to think of centripetal or centrifugal forces, because Dharma and Adharma are Nishkriyas. Does it mean the duality of electro-magnetic influence of Ether? The constitution of an atom is supposed to be a system of electrons (positive and negative).† Had the Jain thinkers any such idea

*(Foot-note is ours) Sir Issac Newton, the great scientific genius of the West (1642-1727 A D), enunciated his first law of motion as follows.

"Every body continues in its state of rest or uniform motion in a straight line, except in so far as it may be compelled to change that by impressed forces"

"Material frictions and reactions are visible as absolute interferences which can change the motion of a body".

—*The Nature of the Physical World, Eddington.*

†This is slightly erroneous, positive electron is not the proton. Proton is 2,000 times heavier than the positive electron discovered in 1932.

about the whole world ? We can only contemplate. But of this much we are certain that Dharma and Adharma are parts of the physical system. They are two different entities *without which the System of reality would be impossible and incomplete*"

Let us see what has a physicist to say about his æther.

In a popular scientific work *An Outline for Boys and Girls and Their Parents* edited by Naomi Mitchison, we find the following on p. 314 :—

"The first problem was, of course, that if light-waves were real waves, they must be waves in *something*. They were plainly not waves in matter; it was necessary therefore to invent something else, *which was not matter*, for them to be waves in. This something they called the "ether", and imagined it as an utterly thin and utterly elastic fluid, that flowed undisturbed between the particles of the material universe and filled all "empty space" of every kind.

What was this ether like ?* Difficulties and contradictions appeared at once.† For it was proved to be: (1) thinner than the thinnest gas; (2) more

*"Material media are penetrated by ether, their molecules being surrounded by it much as the leaves of a tree are surrounded by the air".

†" A serious difficulty arises at this point. It is difficult to imagine the planets as moving with their enormous velocities through (ether) a jelly-like substance without any loss of energy. The motions of the planets are perfectly regular and show no signs of any loss of this kind."

—*Edwin Edser in "Light."*

rigid than steel; (3) absolutely the same everywhere; (4) absolutely weightless; and (5) in the neighbourhood of any electron, immensely heavier than lead !"

Again we have from F. M. Denton's *Relativity and Commonsense* :—

"The Newtonian ether is rigid, yet allows all matter to move about it without friction or resistance; it is elastic but cannot be distorted : it moves but its motion cannot be detected; it exerts force on matter but matter exerts no force on it; it has no mass nor has it any parts which can be identified; it is said to be at rest relatively to the "fixed stars," yet the stars are known to be in motion relatively to one another."

In the *Restless Universe* by Max Born, published in 1935, we read (p. 115) :

"A hundred years ago the ether was regarded as an elastic body, something like a jelly, but much stiffer and lighter, so that it could vibrate extremely rapidly. But a great many phenomena, culminating in the Michelson experiment and the theory of Relativity, showed that the *ether must be something very different from ordinary terrestrial substances.*

"Now an ether is also required for electricity and magnetism ; ...."

Again from *The Nature of the Physical World* by A. S. Eddington, the great authority on the subject, we have (page 31):

"This does not mean that the æther is abolished. We need an æther..........In the last

century it was widely believed that æther was a kind of matter, having properties such as mass, rigidity, motion like ordinary matter. It would be difficult to say when this view died out....*Nowadays it is agreed that æther is not a kind of matter. Being non-material, its properties are sui generis* (quite unique)*......Characters such as mass and rigidity which we meet with in matter will naturally be absent in æther but the æther will have new and definite characters of its own..........non-material ocean of æther."

Although the scientists have firmly come to believe æther as non-material, their attempts to detect it are not yet over The most ingenious and well-known experiment devised to detect æther was performed some fifty-five years ago and is known as the Michelson-Morley Experiment.

The idea of the experiment is this : if all material bodies are really swimming through a limitless ocean of æther, it is quite easy to find how fast they are moving through it. The following analogy will make the point clear : The time taken to row a boat a certain distance up a swift river and down again is always greater than the time taken to row the same distance across the river and back.† Even if water were invisible one could calculate how fast it was flowing by measuring the time either way. In the same way it was argued that if earth were really moving through æther a ray of light would take a longer time to

*This is a brilliant confirmation of Jaina view.

†This fact can be proved mathematically.

go to a mirror and return a certain distance *along* the earth's motion than *across* it.

If æther were a *material* medium for the earth to move through, this seemed bound to be so. The experiment was performed in America by means of the most delicate apparatus and, to the great disappointment of the workers, it was found that both journeys of the ray of light took exactly the *same* time. In the words of Richard Hughes: "It showed that to try seriously to find out facts about the æther, as if it were a *real thing*, would be almost as absurd as to try and find out what wood the Good Shepherd's crook is made of !"

The above experiment was performed in 1881 and in 1905 the experiment was repeated with better precautions. The result was published in the Proceedings of the American Academy of Arts and Sciences, the result again being zero. During the period 1921–25 a series of more exhaustive and elaborate experiments were carried out by Prof. D. Miller on Mount Wilson, California. Five thousand observations were recorded for full periods of 24 hours and extending over ten days.* The final conclusions were that there was a relative motion of the earth and the æther.

This result produced a great commotion in the scientific world for Michelson-Morley Experiment led us to conclude that either there was no material

*It is well to note from this the great zeal and assiduity which these western workers evince in the search after truth. Read carefully their attempts to detect by experiments the *Dharma Dravya.*

æther or that it moves with the earth or that it is at rest in space, while Miller's work indicated æther drag and proved æther to be not non-existent.

More delicate experiments were taken up in Germany in the year 1925 by Tomaschek to detect the motion reported by Miller. The work of Tomaschek was again criticised by Chose in America and he carried out his experiments, published in the *Physical Review*, August 1926, but no such motion could be detected. The Michelson experiment has been again repeated in recent years in a free balloon at heights of nearly 1½ and 3 miles but the authors report that they are unable to confirm or refute the Miller's report. The Miller's results are for some reason inaccurate appears to have been established by the research of Kennedy in U. S. A. published in November 1926 The famous " Chicago rotation experiment " designed to test the effect of the earth's rotation on the velocity of light confirmed the view that *æther was stagnant not moving*.

The physicists have sometimes become very much confused over the æther controversy. In the words of N. M. Bligh, A. R. C. Sc , A. I. C.: " If an ether does exist it would be a four-dimensional concept and its absolute nature would be just as impossible of comprehension as the function which it serves."

Let us review the whole situation. why were the scientists led to such absurd conclusions that æther was thinner than the thinnest gas and at the same time more rigid than steel ; absolutely

weightless and at the same time heavier than lead? (See p. 25-26 *ante*). The answer is: because they then regarded æther as a sort of matter, *i. e.*, they identified Dharma Dravya with Pudgala Dravya; and the discrepancies have now disappeared, when they have come to regard it as a non-material (अमूर्तिक) medium. Remember the latest utterance of A.S. Eddington, M. A., LL. D., D. Sc., F. R. S., Plumian Professor of Astronomy in the University of Cambridge, "Nowadays it is agreed that æther is not a kind of matter."

Why was the Michelson-Morley experiment performed and repeatedly performed with such great refinements? To find out whether the ocean of æther was moving or stagnant. And what is the latest pronouncement on the subject? D C. Miller in his paper "Ether-drift experiment and determination of the absolute motion of the earth" read before the British Association, Leicester, September 1933, and published in the "Nature" February 3, 1934, says:

"The magnitude and direction of the observed effect vary in the manner required by the assumption that the earth is moving through *a fixed ether.*" *

There should be no surprise in the manner in which the scientists have arrived at this conclusion. As we have remarked several times in the Prologue we cite once more the words of A. D.

*This is further supported by the papers published in the Physical Review (American), February 15, 1935 (See 'Discussion on Ether-drag by Cartmel.)

Rikhie: "Scientific men are bound to be revolutionary; to scrap ruthlessly whatever theory is found to contradict facts, and adopt a new one."

So we see that on the basis of the latest scientific evidences two points are well-established. Dharma Dravya, the Æther is non-material, filling all space and not moving.

Compare with this the Jain version:

अमूर्तो निष्क्रियो नित्यो मत्स्यानां जलवद् भुवि ॥

(Dharma Dravya is *formless*, *inactive*, and *eternal*. It behaves like water towards the fish in the world.)

Some people think that with the advent of the theory of Relativity, the ether has been thrown out of science. They should carefully note what the great exponent of Relativity, Prof. Eddington, has to say on this point. "This does not mean that the æther is abolished. We need an æther." (See page 26 *ante*). Thus it is proved that Science and Jain physics agree absolutely in so far as they call Dharma (Æther) non-material, non-atomic, non-discrete, continuous, co-extensive with space, indivisible and as a necessary medium for motion and one which does not itself move.

Adharma.

Let us now take up the next entity in the Sutra, *viz.*, Adharma (अधर्मद्रव्य).

"अधम्मं ठिदि जीव पुग्गलाणं च ।"

(अधर्म्मः स्थितेः जीव पुद्गलानां च)

—कुन्दकुन्दाचार्य कृत नियमसार ॥ २, ३० ॥

(Adharma is the auxiliary cause of rest to soul and matter.)

"स्थिति परिणामिनां जीव पुद्गलानां स्थित्युपग्रहे कर्तव्ये अधर्मास्तिकायः।"

—पूज्यपाद कृत सर्वार्थसिद्धि सूत्र १७.

(The principle which guarantees the permanence of world structure is called the Adharma)

From *Dravya Samgrah*, we have:—

"स्थानयुतानां अधर्मः पुद्गलजीवानां स्थान सहकारी ।
छाया यथा पथिकानां गच्छतां नैव स धरति ॥१८॥"

—*Sanskrit rendering of Prakrit Gatha.*

(Adharma Dravya assists the staying of souls and matter *which are stationary* just as the shade of a tree helps the staying of the travellers. But Adharma *does not stay those which are moving.*)

'छायेव घर्मे तप्तानाम श्वादीनामिव क्षितिः ।
द्रव्यानां पुद्गलादीनामधर्मः स्थितिकारणम् ॥"

—धर्मशर्माभ्युदय काव्यम् ॥ २१, ८४ ॥

(Adharma is the cause of rest of various substances just as the shade of a tree is the cause of staying of persons heated by solar rays or as the earth is the cause of staying of creatures like horses, etc.)

"द्रव्यानां पुद्गलादीनामधर्मः स्थितिकारणम् ।
लोकेऽस्मिन्व्यापकत्वादि धर्मोऽधर्मोऽपि धर्मवत् ॥१८, ७१॥

—चंद्रप्रभचरितम्.

(Adharma is the cause of rest of matter and other substances. Adharma, like Dharma, pervades

all universe (लोकाकाश)* and has other characteristics similar to Dharma.)

"स ह्यकर्ताप्य धर्मस्याजीव पुद्गलयोः स्थितेः ।
नित्योऽमूर्तः क्रियाहीनः छायेव पथिकांगिनाम् ॥"

—वर्द्धमान पुराण ॥ १६, ३० ॥

(Adharma, like Dharma, is without form, inactive and eternal; it is the auxiliary cause of rest to soul and matter as is the shade of a tree the auxiliary cause of rest for the travellers.)

From *Panchastikaya Sar* we have—

"यथा भवति धर्मद्रव्यं तथा तज्जानीहि द्रव्यमधर्माख्यं ।
स्थिति क्रिया युक्तानां कारण भूतं तु पृथिवीव ॥ ९३ ॥"

—*Sanskrit rendering of Prakrit Gatha.*

(The nature of Adharma Dravya is fundamentally the same as that of Dharma But as the earth is the resting place of objects, so is the presence of Adharma Dravya an indispensable condition for

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*The Jain thinkers have divided the universe into two parts, Lokákásha (लोकाकाश) and Alokákásha (अलोकाकाश). In the former the substances Dharma and Adharma permeate and hence in this region bodies move and come to rest, in the latter these media of motion and rest are absent; it is all pure infinite space beyond Lokákásha.

The beautiful scientific exposition of these two regions is given later in this book.

This idea is expressed in the following Gáthá from *Triloksar.*

"धर्माधर्माकाशा गतिरागतिः जीव पुद्गलयोः च ।
यावत्तावल्लोक आकाशं अतः परमनंतम् ॥

—त्रिलोकसार गाथा ॥ ५ ॥

the rest of things in motion, whether they are animate or inanimate.)

Also from Swetámbar Sutra व्याख्याप्रज्ञप्ति we read.

अहम्मत्थिकाए णं जीवाणं किं पवत्तति ? गोयमा ! अहम्मत्थिकाएणं जीवाणं ठाणनिसियणतुयट्टण मणस्स य एगत्तीभावकरणता जे यावन्ने तहप्पगारा थिरा भावा सव्वे ते अहम्मत्थिकाये पवत्तंति। ठाण लक्खणे णं अहम्मत्थिकाए।

This expresses the same conception of Adharma as in the Digambar versions.

To summarise, Adharma Dravya is a non-living, formless, inactive, continuous medium without which equilibrium in the universe would have been impossible. In the absence of which the souls and the atoms would have become scattered in infinite space, that is called Adharma by Jainácháryás. It is the binding force which is responsible for a stable universe; without it there would be chaos and no cosmos.

In the words of Prof. A. Chakravarti (Philosophical Introduction to *Panchastikaya Sar*, p. xxvi-xxvii)—

"The Jain thinker pertinently asks the question why the atoms should be kept together constituting the world of Mahá Skandha ? Why should they not get dissipated throughout Anantákása or infinite space ? Then there would be no world. The very fact that the structure of the world is permanent, that the world is a cosmos and not a chaos implies the existence of another principle which guarantees the permanency of world's struc-

ture and world form. This principle has the function of binding the flying atoms to the world's centre. Its function is then distinctly inhibitive to arrest the flying atoms. This physical principle is called Adharma or rest.........

"Both Dharma and Adharma pervade through space up to world limit. They are absolutely non-physical in nature and non-atomic and non-discrete in structure. The qualities of Pudgala are not found therein. Nor have they the structure of space which is constituted by space points. These two physical principles are perfectly simple. Therefore they may be spoken of as one or as many. They are spacial and yet are non-spacial. They are Amurti and Arupa. They are neither light nor heavy. They are not objects of sense perception. Their existence is inferred only through their function. Such are the characteristics of these two principles which are *distinctly peculiar to Jaina Physics.*"

It is a fact worthy of notice that although all Indian philosophies have devoted very great pains to the theories of world evolution, none of them but the Jains could think of these vital principles of motion and rest without which a stable world structure is not possible.

Let us now try to investigate the modern scientific equivalent of the principle of Adharma as we have proved in the foregoing pages the luminiferous æ her to be the equivalent of Dharma Dravya. Apparently the cementing force in the world is what science calls "gravitation".

Although the law of gravitation has been styled the most extensive generalisation to which the human intellect has ever attained, Isaac Newton, the discoverer of the law, did not quite understand it. In his "Letters to Bentley" Newton wrote:

"You sometimes speak of gravity as essential and inherent to matter. Pray do not ascribe that notion to me; for the cause of gravity is what I do not pretend to know, and therefore would take more time to consider it.........

"Gravity must be caused by some agent acting constantly according to certain laws; but this agent be material or ***non-material*** I have left to the consideration of my readers".

It is worthy of note that Newton himself hit at the truth when he suspected that the real cause of gravitation may be a ***non-material*** agency. In the foregoing pages we have pointed out clearly that Jain metaphysics regards the medium of rest (the gravitation) as non-material. We shall presently see that the Einsteinian view of gravitation regards the cause of gravitation as *passive* and *non-material* (अमूर्तः क्रियाहीनः).

—वर्द्धमान पुराण ॥१६, ३०॥

The Newtonian view of gravitation can be gathered from the following considerations: All bodies with which we are acquainted, when raised into the air and quietly abandoned, descend to the earth's surface. They are urged thereto by a force or effort, which, "although it is beyond our power to trace"*,

Outlines of Astronomy by Sir John F. W. Herschel, Bart. K. H. on page 265.

we call *gravity*. According to the law of gravitation every particle of matter pulls every other particle directly as the product of their masses and inversely as the square of the distance between them, *i. e.*, the heavier the bodies are, the greater is the mutual force of attraction between them and greater the separation, the smaller is the force of attraction; if the distance between them is doubled, the force of attraction would become one-fourth; if the distance is trebled, the force would become one-ninth and so on.

It was the genius of Newton to extend the law of gravitation from the earth to the heavenly bodies. He came early to suspect that the force which keeps the moon in her orbit is none other than the power of attraction of the earth. After years of waiting, trying and experimenting he proved mathematically the truth of his conviction. On page 65 of *The World in Modern Science* Leopold Infeld says:—

"Newton was the first to appreciate that the fall of bodies, the motion of the moon round the earth, the motion of planets relatively to the sun, are all governed by a single general law of gravitation ....

"All bodies mutually attract each other. Take a single case —that of two homogeneous spheres. The law of gravitation tells us the direction of the attraction between these spheres and what physical factors determine its force. The direction is that of the straight line which joins the centres of the spheres; the force of the attraction depends only on

the masses of the spheres and on the distance which separates their centres. Let us double the mass of one sphere and treble that of the other. The force of attraction will be increased 2×3,—that is, six times. Put more briefly and generally:

The force of attraction of two bodies varies directly as the product of their masses. Next assume that the masses of the spheres remain the same but that the distance is trebled. The force of attraction is now reduced by 3×3 times,—*i.e.*, nine times. In other words, the force varies inversely as the square of the distance.

But how is it that this force does not manifest itself in connection with objects which surround us? Why do not chairs, tables, houses tend to move towards each other? The answer is simple: The forces of attraction are extremely small; in the case of objects around us they are insufficient to overcome the forces of resistance to motion—that is to say, the forces of friction—which are always brought into play. If the attracting bodies are very massive, the forces of attraction become appreciable. It is due to them that the earth attracts the bodies in its vicinity and the planets move around the sun and the moon moves around the earth.

Yet another question suggests itself in this connection. If bodies attract each other along the straight lines which join them, how is that that the earth does not fall upon the sun and the moon upon the earth? The principles of Newtonian dynamics supply the answer to this question The direction of motion is *not* that of the direction

of the force. When a stone drops freely from a height, it falls vertically towards the earth's centre. A projectile discharged from a heavy gun, however, describes a parabola, although, here too, the force of gravitation acting upon it is towards the earth's centre. *If we could impart to the projectiles a sufficiently great velocity, we could make them move round the earth as does the moon.*"

Newton extended the concept of gravitation to molecules and atoms also. The propensity of two bodies to react chemically was attributed to the attraction of the particles of one for the particles of the other. Later on the term attraction was changed to *affinity*. The Greek philosopher Democritus* held the view 'that the atoms are attracted to one another on account of their whirling motions'.

/These considerations lead us to the conclusion that gravitation is the cause of the stability of the macroscopic as well as microscopic systems of the universe. But for gravitation, there would be all chaos, there would be no world. The atoms† would

*A Comprehensive Treatise on Inorganic and Theoretical Chemistry. J. W. Mellor; page 785.

†We have pointed out that the earth moves round the sun because of gravitational attraction. In the case of atoms, however, gravitational attraction plays no real part. The masses of electrons and protons are too small for that. On the other hand, here there is an incomparably greater electric force, *i. e.*, the force of attraction between the positive electric charge of the proton and negative electric charge of the electron (See Foot-note page xii of the Prologue). However the law which governs this attraction is exactly similar in form to the law of gravitation, so that it is merely a change of name. It is again a force of attraction which keeps an electron moving round the proton.

be scattered throughout space; the galaxies would disperse; the members of the solar system would be torn off one from the other. Hence the necessity of the important postulate of Adharma Dravya, the gravitation.

It should be borne in mind that Newton regarded the force of gravity as an active force, although acting like an invisible agency. The modification of the concept of gravitation introduced by the author of Relativity, Prof Albert Einstein, renders gravitation quite inactive and thus brings it on the same level as the Adharma Dravya of the Jain philosophers.

The view of Einstein can be approached in the following manner: Suppose this room is a lift;* the support breaks and down we go with ever-increasing velocity, falling freely like a stone. Suppose I am inside the lift and I perform the experiment of dropping an apple held in my hand. Remember that the lift and all things contained in it are falling freely all the while. To my surprise I shall see that the apple cannot fall any more than it is already doing owing to the free fall of the lift. The apple remains poised in my hand. *The force which causes apples to fall, i. e., gravitation as an active agent, disappears,* so far as the man in the lift is concerned.

How ignorant science is of the ultimate nature of gravitation is prettily set forth in a story told by Einstein, as a preliminary to a popular exposition. "Suppose," he says, "that a man were put

*Lifts, electric or hydraulic, are fitted in various buildings, railway platforms, etc., for going from one storey to the other.

into a perfectly dark cage that was poised, motionless, far out into inter-stellar space. The man would not weigh anything, he could move from one side of the cage to the other, or from top to bottom, by the slightest push; he could float in the middle of the cage without touching it. Suppose that, unknown to him, a cable were attached to the top of the cage and some strong motive force applied to the cable; suppose that this force drew the cage swiftly in the direction of a line from the bottom to the top of the cage; and suppose that the force were so steady and noiseless that it was not suspected by the man in the cage. What would he imagine was happening ? He would suddenly discover that he was being drawn against the bottom of the cage; only by a strong effort with his legs could he jump away from the bottom for a moment, and then he would instantly feel strongly 'attracted' back to the bottom. Actually, as we can see from outside, the bottom is being drawn towards him; but he, *accustomed to his notion of gravitation* would never suspect this. He would feel 'attracted by the bottom'. And the most ingenious physicist, supplied with all the most sensitive apparatus, even if he guessed at two reasons for the sensation, could never determine which was the real one."

In the words of Henshaw Ward "Gravitation is an absolute mystery. We cannot guess at any explanation of its nature. If we call it 'a force of attraction'* we are not saying anything; we cannot

*Newton introduced the idea of 'gravitation as a force of attraction' because the state of rest or of uniform motion, which he postulated (see page ?), cannot be observed in the space in which we live. In the Lokákásha there is no space devoid of forces.

conceive how a force can act at a distance without any medium through which to act or how the force can act instantaneously or what could propagate it."

But then what is the *Einsteinian explanation* of falling bodies. According to Einstein the totality of space is so 'curved' that a ray of light, after *travelling in a direct line for a long enough time*, would come back to its starting point. The curving of space in any region depends upon the concentration of matter there, the greater the mass of matter the greater is the curvature or warping. If anyone could become familiar with the abstruse formulæ and calculations of Prof. Eddington it would be natural to suppose that space and time must be warped under the influence of so much gravitational force assembled in one place. How could it be otherwise ? How could space and time be expected to stand the strain of such an *intolerable deal* of matter heaped around one centre ? In the words of H Ward again "To be surprised at the curving of space is to be like a child who is grieved when a house of cards *crumbles* under the weight of a big doll. Certainly space and time must be distorted by gravitation." Why does an apple fall to the earth ? The answer is: the presence of the apple distorts the space in its neighbourhood and the *apple then slips along the line of the greatest slope, not that it is pulled by the gravitational attraction of the earth*.

Nikhil Ranjan Sen, D. Sc.(Cal.), Ph. D. (Berlin), Professor of Applied Mathematics, Calcutta University, in his article on Relativity* writes as follows:

*Published in the *Proceedings of the Physics Seminar*, Allahabad University, 1925, July.

"Though the general theory of Relativity gives a conception of the Universe totally different from the one on which the classical mechanics of Newton and Galileo is based, the new theory succeeds in describing all physical phenomena in conformity with our experience quite as good as the classical theory. With Newton's mechanics gravitation is simply a question of attraction at a distance according to a definite law. *How this mechanism of action at a distance operates, the theory is silent about the point**. Einstein's theory discards the idea of action at a distance and shifts the entire consideration to a totally different ground. The cause of interaction between bodies, according to the new theory, is to be sought in the peculiar nature of the space which surrounds the bodies. The *presence of matter gives an appreciable curvature to the surrounding space and the matter falls down*, as it were, *along the slope of this curvature* according to some definite law.........In Einstein's mechanics, the law remains essentially the same though it is formulated in a more rigorous form out of necessity."

Although the scientists have not come to postulate in clear terms the existence of a separate medium of rest,† like æther the medium of motion,

*If we accept the Jain view the point becomes quite clear. It is the all-pervading invisible medium of rest **अधर्मद्रव्य** through which gravitation makes itself felt.

†The nearest approach to the idea of the medium of rest is the *field concept* gradually being developed by Einstein and others in the name of the Unified Field Theory of gravitation and electromagnetism. The field did not exist for the physicist of early years of the 19th century. For him only matter and its changes were real. But the field concept is growing

they are constantly feeling the necessity of it. They do require a medium for the propagation of gravitation. Hence wrote Henshaw Ward: "We cannot conceive how a force can act at a distance ***without any medium through which to act*** or how the force can act instantaneously or what could propagate it (See page 42 *ante*)" Or in the words of Dr. N. R. Sen "How this mechanism of action at a distance operates, the theory (Newton's theory of gravitation) is silent about the point."

It is the greatest triumph of the Jain theory of Adharma Dravya that science had to postulate the existence of an invisible force of gravitation to account for the stability of the Universe, and that Einstein's modification of the law of gravitation had entirely divested the latter of its active character. Gravitation is now regarded as an auxiliary cause and not an active puller, so that its character is now brought in exact conformity with the Jain view.

"स्थिति-परिणामिनां जीव-पुद्गलानां स्थित्युपग्रहे कर्तव्ये अधर्मास्तिकायः ।

—सर्वार्थसिद्धि ॥

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steadily and matter is being overshadowed by the field. Modern science recognizes two realities. Matter and field. In the words of Einstein and Infeld 'the electromagnetic field is, for the modern physicist, as real as the chair on which he sits.' To quote the same authors further: "A new concept appears in physics, the most important invention since Newton's time: the field. It needed great scientific imagination to realize that it is not the charges nor the particles but the field in the space between the charges and the particles which is essential for the description of physical phenomena." This 'field' is in fact the medium through which the binding forces of gravitation and electromagnetism operate and keep the microscopic as well as macroscopic worlds together.

(The principle which guarantees the permanence of world structure is called Adharma).

And further

"सह्यकर्ताप्य धर्मस्याजीव पुद्गलयोः स्थितेः ।
नित्योऽमूर्तः क्रिया हीनः छायेव पथिकांगिनाम् ॥

—वर्द्धमान पुराण ॥

(Adharma, like Dharma, is without form, inactive and eternal, it is the auxiliary cause of rest to soul and matter as is the shade of a tree the auxiliary cause of rest for the travellers.)

Akasha.

We now take up the next Dravya Akásha (आकाश). According to Umaswami

आकाशस्यवगाहः ॥ ५, १८ ॥

(The function of space is to give place to all other substances; or interpenetrability is the characteristic of Akásha.) Or

जीव पुदगलादीनामवगाहिनामवकाशदानमवगाह आकाशस्योपकारो वेदितव्यः ॥

—पूज्यपाद कृत सर्वार्थसिद्धि ॥

(That which accommodates souls, matter, time and media of motion and rest is called the Space.*)

*According to the Hindu theory of Creation Akásha is the primeval substance from which the other elements arose and therefore, as Dr. Thibaut has pointed out, Akásha must mean some form of subtle matter and not the mathematician's space. For this reason Dr. Thibaut has invariably used the word "Aether" to denote Akásha and according to him this is the only consistent translation. But the Jain thinkers do not believe

The author of *Dravya Samgrah*, Nemichandra Siddhántchakravarti, describes Akásha as follows:

अवगास दाण जोग्गं जीवादीणं वियाण आयास ।
जेणं लोगागासं अलोगागासमिदि दुविहं ॥ १९ ॥

(According to Jainism, that which allows space to Jiva, etc., is to be known as Akásha. The Akásha is of two kinds: Lokákásha and Alokákásha.)

The learned author of तत्वार्थ राजवार्तिक says:

आकाशंतेऽस्मिन् द्रव्याणि स्वयं वाकाशत इत्याकाशम् ।

(जीवादीनि द्रव्याणि स्वैः स्वैः पर्यायैः अव्यतिरेकेण यस्मिन्नाकाशंते प्रकाशंते तदाकाशं, स्वयं चात्मीय पर्यायमर्यादया आकाशत इत्याकाशं) अवकाश दानाद् वा । (अथवा इतरेषां द्रव्याणां अवकाशदानादाकाशमिति पृषोदरादिषु निपातितः शब्दः ।)

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in the theory of creation and consequently they *acknowledged* space to be an objective reality—not aether. In the words of Prof A. Chakravartty (quoted from the *Philosophical Introduction to Panchastikaya Sara*) "curiously the non-Jain Indian systems of thought do not pay any prominent attention to the problem of space. In fact the more influential Indian system of philosophy, the Vedanta uses the term Akásha indifferently to denote space and aether. It is the latter meaning which is more prominent. It is to the credit of ancient Jain thinkers that they took a bold attempt to attack the problem and that with very great success. This fact is perhaps due to their great interest in mathematics. An adequate solution of the problem of space and time is intimately connected with Mathematical Philosophy. It is modern mathematics that has successfully reclaimed once again space and time from the destructive dialectic of the idealistic metaphysics. Space is indispensable to Science and Realistic Metaphysics. The wonders of modern science are all associated with the reality of space and what is contained therein. Hence to the "Indian Realism" space cannot but be real."

The same author Shri Akalankadeva has illustrated the accommodating power of space by saying that Akásha allows other substances to penetrate itself just as water allows a swan (यथा जलमवगाहतेहंस : ॥ ५,१८ (२) ॥) but this analogy should not be interpreted too strictly. In fact a swan displaces a certain volume of water while Akásha being a subtle substance, the idea of displacement does not occur there.

We give below a few more quotations to show that the idea of space in Jainism refers to the mathematician's real space and not to any such thing as the æther:—

"जीवानाम् पुद्गलानां च कालस्या धर्मधर्मयोः ।
अवगाहन हेतुत्वं तदिदं प्रतिपद्यते ॥

—तत्वार्थसार ॥ ३, ३८ ॥

"नित्यं व्यापकमाकाशमवगाहैक लक्षणम् ।
चराचराणि भूतानि यत्रा संबाधमासते ।।"
"लोकालोक नभो भेदादाकाशोऽत्र द्विधा भवेत् ।
अवकाश प्रदः सर्व द्रव्यानां मूर्तिवर्ज्जितः ॥"

—वर्द्धमान पुराण ॥ १६, ३१ ॥

Exactly the same idea is expressed in the Swetambar Sutra व्याख्या प्रज्ञप्ति, शतक १३ उ० ४ सूत्र ४८१ ।

"अवगाहणा लक्खणे णं आगासत्थिकाए ।"

(To accommodate objects is the characteristic of space.)

The nature and the characteristics of space are very fully described in *Panchastikaya Sar* of Swámi Shri Kundkundácharya. We reproduce below the

Sanskrit rendering of the Prakrit Gáthás with translation and part of the commentary from pages 99-104 (S. B. J., Vol. III) edited by Professor A. Chakravarti :

"सर्वेषां जीवानां शेषाणां तथैव पुद्गलानां च ।
यद्ददाति विवरमखिलं तल्लोके भवत्याकाशं ॥ ९७ ॥"

What contains or accommodates completely all Jivás and Pudgalas and the remaining Dravyas is the world space or Lokákásha.

"जीवा· पुद्गल कायाः धर्माधर्मौ च लोकतोऽनन्ये ।
ततोऽनन्यदन्यदाकाशमन्त व्यतिरिक्तम् ॥ ९८ ॥"

Life, matter, the principle of motion and that of rest and also time, these are not distinct from the world. But that which is the same as the world and also distinct from it, is Akásha or space which is infinite.

Commentary.

The constituent elements of the world are the infinite number of Jivás, and the infinite physical objects, the principles of motion and rest and space and time. Of these space contains the other five. The space which is co-extensive with these objects is called Lokàkásha. But this is only a part of real space. Beyond the · Loka there is Alokákásha or Anantákásha. This Anantákásha is pure space. There are no objects animate or inanimate in this Infinite Beyond. Not a tiny molecule of matter nor a stray Jiva would step beyond the limits of Loka. The system of objects is held together by the principles of Dharma and Adharma. And these principles are confined to Lokákásha.

Thus we have to note that mathematically pure, space is recognised to be possible by Jain thinkers.

Akásha thus accommodates the other Dravyas. Why should it not be taken also as the condition of motion and rest? The author shows why it cannot be such a condition.

"आकाशमवकाशं गमन स्थिति कारणाभ्यां ददाति यदि ।
उर्द्धंगति प्राधानाः सिद्धाः तिष्ठन्ति कथं तत्रु ॥ ९९ ॥"

(If space, in addition to accommodating other things conditions their motion and rest, then why do these Siddhás whose tendency is to go upwards come to stay at the summit of the world ?

Commentary.

The author evidently explains why it is necessary to postulate the existence of Dharma and Adharma. Cannot Akásha be credited with the function of motion and rest in addition to its own function of accommodating things ? According to the author such a hypothesis would be impossible. It would be conflicting with other facts, for if it is also the condition of motion and rest, then wherever there is Akásha there should be free chance for motion and rest. But neither a single Jiva or a single atom of matter could step beyond the limit of Lokákásha though there is Akásha beyond. Therefore the author concludes that space is not the condition of either motion or rest. These require independent principles as their condition. Akásha cannot be a substitute for Dharma and Adharma. The Jain System evidently considers the world incomplete

and unreal without the statical and dynamical principles.

In Gáthá No. 100, the author has emphasised the same point again. "Since there is a definite Loka," he says, "and since there is space beyond, there must be something besides space which maintains the integrity of the system of things and persons. For space itself cannot have that function of maintaining the unity of the world."

In Gáthá No. 101 we have—

"यदि भवति गमन हेतुराकाशं स्थान कारणं तेषा ।
प्रसजत्य लोक हार्निलोकस्य चान्त परिवृद्धि ॥ १०१ ॥"

(If space be the condition of motion and rest, of life and matter, then there would happen the disappearance of Aloka or the beyond and the destruct on and dissipation of Loka or the world.)

Commentary.

As a matter of fact, the world is an integral system of things, living and non-living, existing in space. That there is some force or power which holds the constituent elements of the world together is a necessary pre-supposition even of modern science. *It is really wonderful that Jain thinkers several centuries ago felt the same intellectual necessity of supposing a physical force which maintains the cosmic unity.* The reason given for that hypothesis is still more interesting. If there is no such power and if things living and non-living were left in space by themselves without a further principle to hold them together, there would be only chaos, no

systematic world. This argument must be considered very important for it gives us an insight into the scientific ideas of the ancients. *The positive science of ancient Indians must have been fairly advanced in order to promulgate such physical theories as are contemplated by the author.*

In Gáthá 102, the same fact has again been asserted :

"तस्माद्धर्म्माधर्म्मौ गमन स्थिति कारणे नाकाशं ॥"

(Dharma and Adharma, *i. e.*, Æther and gravitation are the conditions of motion and rest respectively, and not Akásha or space.)

In Gáthá 103 the author states that Lokákásha or world-space, Dharma and Adharma, are all co-extensive and coincident. Hence they may be considered as one conventionally as they are all incorporeal entities in the same locality. But they are in reality different from one another on account of their functional difference.

"धर्म्माधर्म्माकाशान्यपृथग्भूतानि समानपरिमाणानि ।
पृथगुपलब्धि विशेषाणि कुर्वन्त्येकत्वमन्यत्वं ॥१०३॥"

(Dharma, Adharma and space are mutually interpenetrating and coincident. Hence they are one from the point of locality; they are of the same size and form and constitute an inseparable unity. But from the difference of function they also exhibit their diversity.

Commentary.

This Gáthá is interesting for this reason that Dharma and Adharma being constitutive elements

of the world are said to be confined to Lokàkàsha. Their influence is not felt beyond the boundary of the world, for their influence is fundamentally related to things material and spiritual. These two mysterious physical principles are all-pervading and co-extensive with the world space. Their existence cannot be inferred from their difference of locality. There is no such difference. But yet they have fundamentally different functions and on account of these differences they are really diverse. In short they are in one *Pradesha* (unit of space) but different as *Vastus*, *i. e.*, they have a unity of locality with diversity of function and nature.

This functional difference is emphasised by the author only because these three Dravyás are Amurta. There is no other way of differentiating them unlike physical objects which can be distinguished by sense qualities and unlike Jivas which can be differentiated by conscious qualities. Dharma and Adharma have to be determined only by their function in the economy of the physical world.

(*Quotation ends here.*)

Now compare the purport of these beautiful Gàthàs with the proclamations of modern science. Just as the Jain thinkers have divided space into Lokàkàsha and Alokàkàsha, *i. e.*, a finite universe and an infinite void beyond, so is the verdict of the modern mathematician.

"Strangely enough the mathematicians reckon that the total amount of matter which exists is limited, and that the total extent of the universe

is finite. They do not conceive that there is a limit beyond which no space exists but that the totality of space is so 'curved' that a ray of light, after travelling in a direct line for a long enough time, would come back to its starting-point. They have even made a preliminary estimate of the time a ray of light would require for the round trip in the totality of curvature—not less than ten trillion, *i. e*, 10000000000000000000 years. And such a space is very cosy quarters compared with infinity. A mathematician feels positively cramped in it."

—*"Exploring the Universe" by H. Ward, page* 16

Again on page 266, the same author writes:—

"Think of the most remote and abstract of all the theorems of Relativity—that the universe is finite. This is quite inconceivable; no astronomer can secure any mental picture of a jumping-off boundary beyond which there is no space. ......When a computation implies that space is "finite" the mathematician cannot unmake his brain and visualize finite space. He does not even try to do so. But he presumes that the equation has some concrete meaning and that the meaning may in time take form and be revealed as a serviceable fact—dim, but actual—on the border of the unknown."

Mr. Ward may, please, note that it is not in the least necessary 'to unmake the brain and visualize finite space' if we slightly modify our present theory and accept the Jain idea of a finite universe and an infinite empty space beyond, in which exists

nothing, no soul, no matter and no media necessary for motion and rest. How very reasonable and easily conceivable it is to suppose that beyond the boundary of the finite universe the medium of motion (Dharma Dravya of Jain philosophy) is absent and thus a ray of light or any other form of energy or even a single particle of matter cannot go beyond Lokákásha *i. e.* beyond the boundary of the finite universe. Thus the stability of the universe is established without postulating the idea of 'curving of space', the latter being a difficult pill to swallow.

Einstein, however, has taken up a more correct view and accordingly the great relativist Professor Eddington writes on page 80 of his book "*The Nature of the Physical World*":

"I suppose that every one has at some time plagued his imagination with the question, Is there an end to space? If space comes to an end, what is beyond the end? On the other hand, the idea that there is no end, but space beyond space for ever, is inconceivable. And so the imagination is tossed to and fro in a dilemma. Prior to the relativity theory the orthodox view was that space is infinite. No one can conceive infinite space; we had to be content to admit in the physical world an inconceivable conception—disquieting but not necessarily illogical. Einstein's theory now offers a way of out of the dilemma. Is space infinite or does it come to an end? Neither. *Space is finite but it has no end;** "finite but unbounded" is the usual phrase."

*This is very approximate to the Jain view of Lokákáshs and Alokákásha.

The same view was expressed by Professor **A. C.** Banerji, M. A. (Cantab.), M. Sc., F. R. A. S., I.E.S., Professor of Mathematics, Allahabad University, in a lecture on "The Expanding Universe" delivered at the Science Congress, Bombay, 1933. Says he:

"According to Einstein's original theory of Relativity, dimensions of space are determined by the amount of matter it contains. Space, if there be matter inside, bends round until it closes up. The more matter there is, the smaller space there must be and 'space could only be of literally infinite extent if it contained no matter at all.'* So matter is responsible for the curvature of space dimensions. So in Einstein's space containing matter, if one goes right on in one direction one does not get to infinity but gets back to his starting-point again 'Closed space differs from an open infinite in the same way that the surface of a sphere differs from the infinite plane' We say that the surface of a sphere is (1) a curved surface and (2) a closed surface enclosing a three-dimensional volume. Similarly we can say that our three-dimensional space is (1) a curved space and (2) a closed space, enclosing a four-dimensional† continuum. *In Einstein's world the time dimension is uncurved and so may extend to infinity.* It is what is called Einstein's cylindrical world."

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*Mark the very interesting, at the same time, strange argument against the non-infinity of space.

†Einstein's theory regards the universe as a four-dimensional space-time continuum, the three directions of space being combined with the fourth dimension of time. A brick with its length, breadth and thickness must grow in the direction of time in order to be a brick. A brick existing for no time is absurd.

The last words which we have italicised are worthy of notice. In plain simple words they mean that the universe extends in the direction of time from an infinite past to an infinite future. To be more explicit, *there was never a beginning of the universe nor will it ever come to an end* This fact is the fundamental substratum of Jaina philosophy. It regards the universe with its contents as eternal and uncreated :

"जीवाः पुद्गल काया धर्माधर्मौ तथैव आकाशम् ।
अस्तित्वे च नियता अनन्यमया अणुमहान्तः ॥ ४ ॥"

—पंचास्तिकाय समयसार ॥

(Souls, matter, the media of rest and motion and finally space, these are the entities which are *eternal, uncreated* and of immense magnitudes.)

What greater confirmation we require for the truths enunciated by the Jain Acháryás ? The Cylinder Theory of the universe is explained in more clear terms by Professor N. R. Sen, D. Sc., the famous worker on the theory of relativity He quotes the following view of Professor Einstein . -*

"Einstein himself asserts that the universe consisting of large and small masses hanging apparently in infinite space is not in fact infinite One suggestion from his theory is that the universe of four dimensions is finite in spatial directions and

*From Dr. Sen's article on 'Relativity' published in the Proceedings of the Physics Seminar, Allahabad University, July 1925.

infinite in the direction of time. It is like a cylinder whose surface is bounded in some direction, *viz.*, across the lines which generate the cylinder. This finite dimension corresponds to the three spacial dimensions of our world of perception. But the cylinder is also infinite in two other directions, *so is also our universe which is infinite in the dimension of time running from the infinite past into the infinite future* "

There can be no clearer pronouncement than this about the finite-ness of the Loka, *i. e.*, universe and its eternity, thus establishing the Jain view point beyond the shadow of a doubt. It should be noted, however, that while Jain philosophy regards only a part of Loka as finite and an infinite space beyond the Einsteinian view regards the whole Loka as finite with nothing beyond it. For, says Eddington (page 137) -- "In any case the physicist does not conceive of space as void." Let us hope that this little difference will disappear as science advances for, as again in the words of Eddington, as "it is inconceivable that there was once a moment with no moment preceding it," so it is inconceivable that there should be no space beyond a certain space.

Pudgala.

The last substance mentioned in the Sutra is Pudgala which falls within the category of non-living substances. On page 1 we have translated this word as 'matter and energy' and it is exactly in this sense that the term has been used by the Jain writers. At this stage we shall discuss

only one phase of Pudgala Dravya. The word Pudgala has the following derivation:

" पूरयन्ति गलयन्ति इति पुद्गलाः "*

(Pud पुद् means 'to combine' and gala गल means to dissociate.)

Hence the root-meaning of the word Pudgala is: "that which undergoes modifications by combinations and dissociations." This definition of Pudgala is so full of significance and deep meaning that those who are conversant with the developments in modern atomic physics can fully admire and appreciate the use of the word 'Pudgala' to denote matter. We shall describe in brief how one form of matter is changed into another form by the combinations and dissociations of elementary constituents of matter, *viz*, electrons and neutrons. The nature of the electrons has already been explained on p. 13. What neutrons are we shall explain in the following pages.

"In the last century the childish musings of the alchemists† were regarded as things definitely of the past; science had no more use for them; it had triumphed—so it was thought—in establishing that elements were unchangeable and indivisible In the present century, however, the problem which the

*(१) "पूरण गलनान्वर्थ संज्ञत्वात्पुद्गला"—राजवार्तिक अ० ५ सूत्र १।२४।

(२) "वर्ण गंधरस स्पर्शैः पूरणं गलनं च यत्।
कुर्वन्ति स्कंधवत्तस्मात् पुद्गलाः परमाणवः"—हरिवंश पुराण सर्ग ७

(३) "पूराणात पुत् गलनति गलः इति पुद्गलः"—शब्द कल्पद्रुम कोष।

(४) "छव्विह संठाणं बहुविह देहेहि पूरदि गलदित्ति पोग्गलो"—धवला ग्रंथ।

†Alchemists were those ancient workers in chemistry who posed to have discovered the methods of converting copper or mercury into gold.

alchemists set themselves has again been revised, though in quite a different form. It will presently be seen that this very miracle of alchemy has been performed in the Cavendish Laboratory under Lord Rutherford's direction. In the phenomenon of radio-activity elements are seen transforming themselves of their own accord into others."

—*The World in Modern Science by Infeld.*

As explained in figure 3 on page 15 all atoms are an assemblage of electrons and protons in different numbers. Uranium, a metal element, is radio-active. Radio-activity has nothing to do with radio broadcasting. It is a technical term which expresses a peculiar property of certain metals. Uranium emits, day and night, unceasingly three kinds of rays which are denoted by Greek names, alpha, beta and gamma. Alpha rays are streams of particles which are formed by the partial combination of electrons and protons inside the nucleus of an atom. Beta rays are streams of electrons; and gamma rays are the rays of the nature of light. When an atom of uranium loses three alpha particles it is converted into an atom of radium*. The atom of radium is again radio-active, *i. e*, it emits day and night the same three kinds of rays When one atom of radium loses five alpha particles it is converted into the metal lead.

*Radium is the costliest metal on earth, the present price being about Rs. 3,00,000 per tola. It is being successfully used in the treatment of cancer of the heart and other deadly diseases of the skin.

This is a confirmation of one part of the definition of Pudgala. This shows the dissociative (गलयन्ति) character of Pudgala Dravya, one form of matter changing into another form by the separation of electrons and protons. In the adjoining figure is given the full chain of radio-active changes in uranium.

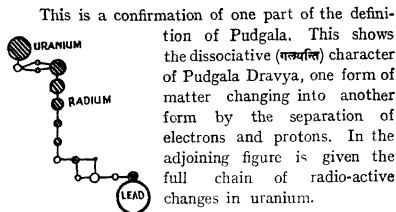



Fig. 4.

(The chain shows the formation of different substances by the *separation* (गलयन्ति) of alpha and beta particles from within the atoms. The circles of different sizes show the relative weights of the different substances formed.)

In confirmation of the above series of changes in uranium metal it may be mentioned that there exist, in the earth's crust, rocks which are rich in uranium. Radio-active disintegration, *i. e*, the breaking up of atoms by the emission of alpha and beta rays, is unceasingly proceeding in these rocks. Geological researches have shown that the end-product *viz.* lead metal is always found embedded in these rocks together with uranium in a fixed proportion. It is in fact with the help of the uranium-lead ratio that the age of these rocks is estimated, thus establishing beyond doubt that lead is formed by the gradual disintegration of uranium.

We shall now give an account of the work which has been done in the Cavendish Laboratory of England in order to produce one kind of atom from another kind artificially.

Fig 5 shows the nucleus (central core) of an atom of nitrogen gas and at the right-hand

top corner of the same is shewn an alpha particle which has been used as a bullet in the experiment.

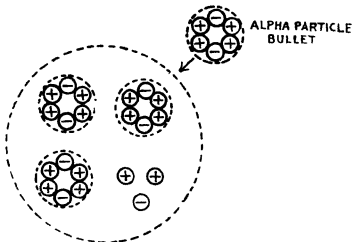



Fig 5 Nucleus of Nitrogen atom before bombardment

The bigger circle represents the central core (nucleus) of the nitrogen atom It consists of three alpha particles, two protons and one electron. The three alpha particles are shewn by three smaller circles within the big circle. The symbol (+) represents a proton and the symbol (—), an electron. Each alpha particle again consists of four protons and two electrons

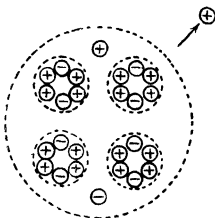



Fig. 6.
Nucleus of Oxygen atom formed by bombardment.

The above figure shows that an alpha particle bullet from an outside source is just on the point of being shot into the interior of the nucleus. What happens after the bombardment is shewn in the next figure No. 6.

In the words of Prof. Infeld "The catastrophe produced by a collision between the nucleus of the atom and the bombarding alpha particle expels a proton from the nitrogen

atom. One asks, therefore, what further happens to the bullet which has caused the catastrophe? What becomes of the alpha particle after the collision? To this question, too, experiment gave its answer a few years ago. *The bullet remains embedded in the nucleus at which it was projected.*" The resulting atom shewn in Fig. 6 is the atom of oxygen. There can be no better example of the combinational (पूरयन्ति) character of Pudgala Dravya. The comparison of figures 5 and 6 clearly shows how the foreign alpha particle has filled an empty place and produced an atom of oxygen from an atom of nitrogen. Thus the definition of Pudgala *viz.* पूरयन्ति गलयन्ति इति पुद्गलाः establishes itself fully. However we shall give two more illustrated examples before closing the subject.

Fig. 7 shows the bombardment of the nucleus of lithium atom with a proton bullet. The figure clearly shows that if a proton is added to the nucleus, another alpha particle will be completed, for there are already three protons and two electrons in the free state, and the addition of one more proton will make four protons and two electrons; that means an alpha particle. This is another example of पूरयन्ति, *i. e.*, filling a gap. At the same time the lower figure shows that the

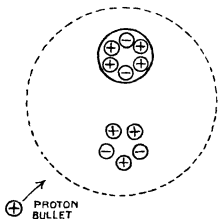
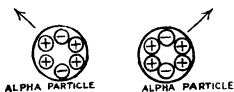



Fig. 7. *Above.*—Lithium Nucleus before collision.
Below.—Lithium Nucleus after collision.

nucleus bursts and the two alpha particles fly in opposite directions, *i. e.*, **गलयन्ति.** It shows that in this case the processes of (पूरयन्ति) combination and dissociation (गलयन्ति) proceed side by side resulting in the transformation of a lithium atom into two alpha particles.

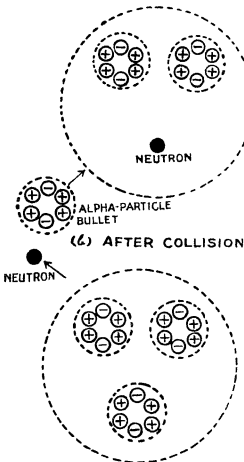
The case of beryllium metal is interesting. As Fig. 8 shows there are two alpha particles and one neutron inside its nucleus. (Neutron is another fundamental particle which consists of one proton and one electron as in Fig. 2 of p. 14 but not separated by a distance; they are, in fact, in very close union with each other.)

The lower circle of Fig. 8 shows how the bullet gets embedded in the nucleus and the neutron is shot

Fig. 8. *Above.*—Beryllium nucleus before collision.
Below.—Beryllium nucleus after collision.

out. This is again a case of combination and partial dissociation. The resulting atom is an atom of carbon, *i. e.*, beryllium is converted into carbon by the alpha particle bullet.

Experiments have been performed with many* more metals but these examples will suffice. It should be noted that in all these experiments alpha particles or proton bullets of very great energy were produced by highly technical methods and then shot into the atoms so that the bullets may penetrate the interior of the nucleus and produce the transformations recorded.

This discussion leaves no doubt that the selection of the word Pudgala for matter is full of very deep meaning and must have been selected after a profound thinking. It is worthy of note that the use of this word is quite peculiar to Jainism; it does not even exist in the lexicons edited by non-Jain writers.

Sutra 2.

द्रव्याणि ॥२॥

(Dravyáni)

According to Swetámbarás, this Sutra has been combined with the following Sutra and we have

"द्रव्याणि जीवाश्च"

(Dravyáni Jivàshcha).

*The discovery of artificial radio-activity made by Irene Curie and F. Joliot in 1934 has given us many more transformations such as conversion of aluminium into phosphorus, phosphorus into silicon, magnesium into silicon, silicon into aluminium, sodium into radio-sodium, radio-sodium into magnesium, sulphur into phosphorus, and many more all brought about by alpha particle, proton or neutron bombardments.

which means that Dharma, Adharma, **Akása,** Pudgala and all Jivas. these are the five Dravyas and *not time.*

According to Digambaras, the Sutra means

धर्म-अधर्म-आकाश-पुद्गलाः द्रव्याणि ॥

i. e. Dharma, Adharma, Akása, and Pudgala are the Dravyas.

Then in Sutras 3 and 39 we have

"जीवाश्च" ॥३॥

"कालश्च" ॥३९॥

i. e., Jivas and Time are also Dravyas.

Thus according to the Digambar version there are six Dravyas or Realities : Jiva, Pudgala, Dharma, Adharma, Akása and Kála.

Dravya has been defined as

"पर्यायैः द्रूयन्ते तानि द्रव्याणि"

or

"पर्यायान द्रवन्ति तानि द्रव्याणि"

—पूज्यपाद आचार्यकृत "सर्वार्थसिद्धि"॥

(That which undergoes modifications is a Dravya.)

To give one example of such modifications, consider an ingot of gold. Suppose we make an ornament out of it. The original mass of gold suffers a modification, the fundamental form is destroyed (व्यय). a new form is produced (उत्पाद) but the sub-

stance gold persists (ध्रोव्य) throughout the change. Hence the following Sutras—

उत्पाद व्यय ध्रौव्य युक्तं सत् ॥३०॥

सद् द्रव्य लक्षणम् ॥२९॥

—तत्वार्थसूत्र अ० ५ ॥

(*i. e.*, every substance in the universe possesses the quality of permanency (ध्रोव्य) with generation (उत्पाद) and decay (व्यय) as modifications of itself. It is technically called sat (सत) and sat (सत) defines a substance or a Dravya).

In तत्वार्थ राजवार्तिक we read

"स्वजात्य परित्यागेन भावन्तरा वाप्तिरुत्पादः। तथा पूर्व भाव विगमो व्ययः। ध्रुवे स्थैर्य कर्म्मणो ध्रुवतीति ध्रुवः।" अ० ५,२९ (१,२,३)

उत्पाद is the modification of a substance without leaving its own kind; व्यय is the disappearance of a form and ध्रोव्य consists of the persistence of the fundamental characteristics throughout various modifications.)

Professor A. Chakravarti has summarised in a beautiful way the characteristics of a Dravya. "The term Dravya denotes any existence which has the important characteristic of persistence through change. Jain conception of reality excludes both a permanent and unchanging real of the *Permenidion* type and also the mere eternal flux of *Haraclites*. An unchanging permanent and mere change without substratum are unreal and impossible abstractions. Jain system admits only the dynamic reality or Dravya. Dravya, then, is that which has a permanent substan

tiality which manifests through change of appearing and disappearing. *Utpada*—Origin, *Vyaya*—decay and *Dhrouvya*—permanency form the triple nature of the Real. To emphasize the underlying identity also would end *Vedantic* conception of this Real as *Brahman*. To emphasize the change alone would result in the Kshanika Váda (क्षणिक वाद) of the Buddhist. The reality is a stream of discrete and momentary elements. The concept of Dravya reconciles both these aspects and combines them into an organic unity. It is an identity expressing through difference, a permanency continuing through change. It corresponds to the modern conception of organic development rather in its Hegelian aspect. It has duration; it is movement; it is the *Elan Vital*. The five Astikáyas and Káli or time are the six Dravyas or real existences."

—*Historical Introduction*, पंचास्तिकायसार, p. XXIX.

The Jain view of Dravya expressed in the summary quoted above is based on the following gáthás of Panchástikáya Sár :

"ते चैवास्तिकायाः त्रैकालिक भाव परिणता नित्याः ।
गच्छन्ति द्रव्य भावं परिवर्तन लिंग संयुक्ताः ।६॥

(These five Astikáyas, though manifesting themselves in multifarious forms, maintain their permanency and together with time, they constitute the six Dravyas, since time also possesses the characteristic of persistence through change and is therefore a Dravya.)

"द्रव्यं सल्लक्षणकं उत्पाद व्यय ध्रुवत्व संयुक्तं ।
गुण पर्यायाश्रयं वा यत्तद्भणन्ति सर्वज्ञाः ॥१०॥

(The All-knowing Tirthankaras have said that whatever has substantiality, undergoes birth and death through persistence and is the substratum of *qualities* and modifications is called the Dravya.)

Three points have been stressed in this gáthá. Dravya is 'Sat', substantiality or existence: it has the quality of permanence through birth and death and lastly it is the basis in which attributes rest and modifications take place. It should be noted, however, that birth does not mean 'coming into being out of nothing'; it means the production or development of a new form. Death does not mean the complete annihilation of the substance but simply the death of the previous form. This dialectical triad of birth, death and permanence ' is not only recognized by the scientists like Darwin and Spencer but by the great French philosopher, Bergson, who raised it to an important philosophical principle'.

—(*Chakravarti*)

Lastly the qualities or attributes in order to be real must have an objective basis and such a basis is a Dravya.

Now we give below the evidence of present-day science on the subject of permanence of substances through birth and death. The sphere of ' Science' is the Pudgala Dravya (*i. e.*, matter and energy) only since soul and other Amurta Dravyas are not amenable to measurement and Science means 'measurement'. Consequently laws have been investigated and formulated concerning matter and energy only. The *principle of conservation of matter* and the *principle*

of conservation of energy are the two fundamental laws of physics.

"This theorem (the law of conservation or persistence of energy) is usually considered to be the flower of the mechanical world,—the highest and most general theorem of natural science, to which the thought of many centuries has led."

—*J. W. Mellor, Vol. I, p.* 269.

Referring to this doctrine Prof. A. N. Whitehead, D. SC., F.R.S., writes on p. 126 of his book "Science and the Modern World": "The doctrine of energy has to do with the notion of quantitative permanence underlying change."

Mark the coincidence of the words 'permanence underlying change', the words which we have oft used in the translation of the previous gáthás. It means nothing but उत्पाद, व्यय, ध्रौव्य.

Writing under the heading "Energy, like matter, is indestructible" Dr. J. W. Mellor writes on p. 691: "Whenever it has been possible to make accurate measurements, it has been found that when any quantity of one form of energy is made to *disappear*, an equivalent quantity of another form, or forms of energy *appears*."

L. A. Colding, in his *Thesis on Energy* (Copenhagen, 1843) said:

"Energy is imperishable and immortal and therefore, wherever and whenever energy seems to vanish in performing certain mechanical or other work, it merely *undergoes a transformation and re-appears in a new form but the total quantity of energy still*

abides." The italicized words again mean the उत्पाद, व्यय, ध्रौव्य in the Pudgala Dravya.

In the brilliant writings of the French physicist Sadi Carnot (died 1832) the following words occur:—

"True enough, (energy) may change its form or produce sometimes one kind of motion and sometimes another, but it is never annihilated." It means permanence through change.

What has been said about energy is equally true about matter. A few years after Lord Mahavir, Democritus, the great Greek philosopher also taught—*ex nihilo nihil fit, et in nihilum nihil potest reverti*—nothing can ever become something, nor can something become nothing.

In the nineteenth Century Herbert Spencer announced that "the annihilation of matter is unthinkable, for the same reason that the creation of matter is unthinkable, the reason, namely, that nothing cannot be an object of thought."

The latest work of the great chemist Dr. J. W. Mellor contains the following statements:

"In all changes of a corporeal nature, the total quantity of matter remains the same, being neither created nor destroyed............Superficial observation might lead to the belief that a growing tree, the evaporation of water, and the burning of a candle prove the creation and destruction of matter but a careful study of these and innumerable other phenomenæ, has shown that the apparent destruction of matter is an illusion............The law of persistence of weight or the so-called law of indestructi-

bility of matter means that............*substance persists while matter changes its form.*"

—*Inorganic & Theoretical Chemistry, Vol. I, p.* 101-2.

Hence उत्पाद, व्यय, ध्रौव्य, as characteristics of a substance is established on modern evidence

Sutra 3.

जीवाश्च ॥३॥

(Jivashcha)

(Souls are also included in the category of substances)

As pointed out on p. 64-65 the Swetámbars and Digambars both agree in regarding soul as a substance One more evidence from Swetàmbar Sutras is given below :

" कइ विहाणं मंते ! दव्वा पण्णत्ता ? गोयमा ! दुविहा पंणत्ता, तं जहा—" जीव दव्वा य अजीव दव्वा य" । "

—अनुयोग० सूत्र १४१॥

The existence of soul can be proved on various grounds The faculty of knowing and perceiving, the sensations of pleasure and pain cannot inhere in nothing, nor can volition be the function of pure non-entity. All these must be regarded as states of something which exists and it is this 'something' which we call 'soul substance'. Psychical researches of eminent scientists, like Sir Oliver Lodge, have proved the existence of souls. It should be noted, however, that the investigations of

Experimental Science say nothing, either this way or that way, about the existence of soul, the reason being that non-material substances cannot be subjected to experiment and hence do not come within its province.

In *Exploring the Universe* by Henshaw Ward the following words occur on p. 230 :—

"Science is now, and must increasingly become, a limited field of endeavour. Its materials are only those forces which can be measured and predicted with precision by all experimenters alike. If there exists in man a free will, a conscience, a power of self-sacrifice, a social mind or a consciousness of kind, *these forces are beyond the pale of science...* The science of to-morrow, therefore, cannot include any such forces as we commonly conceive at present when we use the words, mind or soul or will or purpose."

To ask Science to give its verdict with regard to the existence of soul is to ask an engineer to perform an operation on the injured part of your body. Don't think that the engineer is silly if he refuses to attend to you. It is not his province. But even the scientists, as logical thinkers, have felt that over the body and the intellect there rules a heaven-sent soul and *regarding it as some form of energy* they have made attempts from time to time to investigate its nature.

An account of a recent investigation carried out by a prominent South African doctor and an engineer in London was published in the "Jayaji Pratap" of Gwalior in the issue, dated June 17, 1937, under

the caption "Scientist Seeks the Soul." We reproduce below certain portions of that article;

"The doctor and the engineer both thought that the secret of life lay in some kind of energy, probably electrical....Intricate apparatus was designed and built by the engineer and the experiments started. Animals were used at first. Their apparatus proved that every animal was born with a definite electric charge. They were able to record and tabulate this energy..They found that the more intelligent animals had a higher charge than the lower forms. At the moment of death the charge disappeared. In the animal experiments the records showed that the charge remained more or less the same throughout life except when the animal was breeding".

In the case of human beings they found the same laws holding and we read: "The babies were born with a definite charge. After death the charge vanished. An average human charge, they found, was 500 volts. As the subject grew older the charge increased not with age, but according to the type of character the subject was developing. The two men began to think that they were on the track not only of life but of the soul, so long sneered at by scientists. In coarse animal natures the charge remains low and in cases of mental disease and lunacy the charge dropped. They found that male babies had a higher charge at birth than female babies, but that the female could catch up and pass the male according to the various characteristics shown."

Now they are trying to find out where does the electrical charge go at death. They think that as

energy it cannot disappear but must go on existing in some form. It is, therefore, reported that "the engineer is planning a new recording machine. This will not take the reading definitely from the body of the subject but from the atmosphere around it. It is based on a theory that there is an aura around every human being.

With this new machine they hope that they will be able to take the reading of the atmosphere in a room or in a building such as a hospital.

They hope that when death occurs the needle of the recording machine will not drop but will remain steady, proving that the charge is still there, in the æther filling the room.

The theory they hold now is that when a patient dies the energy leaves the body, but hovers, for a time, in the atmosphere surrounding the body."

The reading of the above account at once conveys the idea that this is not a step which will lead to the discovery of soul, since soul is a non-material, non-tangible body. But it is a brilliant confirmation of the Jain view of Taijas-sharir (तैजस-शरीर) or electrical body which is closely associated with the soul. Compare the above with the following account of the Taijas-sharir given in Jain Shástrás:—

"The Taijasa is composed of electric or magnetic matter and is a necessary link between the outermost body and the Kármán Sharir (the latter being the compound arising from the union of spirit or matter)."

—*Key of Knowledge by C. R. Jain, p.* 822.

"The Taijasa Sharir is a coat of luminous matter thrown over the Kármán Sharir and forms an atmosphere or aura of light round it."

—*Ibid, p.* 825.

"Taken together, the Taijasa and the Kármán Shariras form only one organism, and accompany the soul throughout its evolution as a migrating ego."

—*Ibid, p.* 825.

"Death signifies the departure of the soul with its two inner bodies, the Kármán and the Taijasa, from the body of gross matter."

—*Ibid, p.* 834.

The comparison is striking and needs no comment. The scientists have after all discovered one physical counterpart of the soul and hence we are quite justified in regarding the soul as a separate non-material substance.

Sutra 4.

" नित्यावस्थितान्य रूपाणि " ॥४॥

Nityá vasthitánya rupáni

=(धर्मादीनी, कालः, जीवाश्च, द्रव्याणि)* नित्यावस्तिथान्य रूपाणि ॥४॥

(The six substances Jiva, Ajiva, Dharma, Adharma, Akása and Kála are permanent in their

*Dharma, Adharma, Akása and Pudgala are embodied in Sutra 1, Kála or Time in Sutra 39, Jiva in Sutra 3, and the term द्रव्याणि (Dravyáni) is taken from Sutra 2

nature, fixed in number as the sole constituents of the universe and (with the exception of Pudgala Dravya) are all without form, *i. e*, they are devoid of the characteristics of matter, *viz.*, touch, taste, smell and colour.)

The great Achárya Shri Kundkunda Swámi has expressed the same view in the following gáthás of Panchástikáya Sár. (Sanskrit rendering of the gáthás is given :—

"जीव पुद्गल कायाः आकाशमस्ति कायौ शेषौ ।
अमया अस्तित्वमयाः कारणभूता हि लोकस्य" ॥२२॥

"येषामस्ति स्वभावः गुणैः सह पर्यायैर्विविधैः ।
ते भवन्त्यस्ति कायाः निष्पन्नैयस्त्रैलोक्यम्" ॥५॥

"तेचैवास्तिकायाः त्रैकालिक भाव परिणता नित्याः ।
गच्छन्ति द्रव्य भावं परिवर्तन लिंग संयुक्ताः ॥६॥

(*Tr.*—The souls, the material bodies, the space, and the remaining two, *viz*, Dharma and Adharma are the eternal existences which constitute the universe. They are called Astikáyás.

Astikáyás are those which manifest themselves in various forms through their numerous qualities and modifications. They fill all the three worlds, *i. e.*, they are the constituent parts of the universe.

The five Astikáyás though manifesting themselves in various forms, maintain their permanent character and together with Time constitute the six Dravyás.)

In Swetàmbar *Nandi Sutra,* the same idea is very clearly expressed as :—

"पंचत्थिकाए न कयाइ नासी न कयाइ नत्थि, न कयाइ न भविस्सइ भुविं च भवइ अ भविस्सइ अ धुवे नियए सासऐ अक्खए, अव्वए, अवट्ठिए, निच्चे अरूवी ।"

—सूत्र ५८॥

The great commentator Shri Pujyapáda Achárya comments on this sutra as follows:—

"नित्यं ध्रुवमित्यवर्थः । धर्मादीनि द्रव्याणि गति हेतुत्वादि विशेष लक्षण द्रव्यार्था देशादस्तित्वादि सामान्य लक्षण द्रव्यार्था देशाच्च कदाचिदपि न व्ययन्तीति नित्यानि । इयत्ताऽव्यभिचारादवस्थितानि धर्मादीनि षडपि द्रव्याणि कदाचिदपि षडिति इयत्वं नाति वर्तन्ते । न विद्यते रूपमेषामित्यरूपाणि, रूपप्रतिषेधेन तत्सहचारिणां रसादीनामपि प्रतिषेधः ।"

(These Dravyas are eternal and unchanging in their characteristics, the medium of motion cannot become the medium of rest or the living cannot become the non-living. The number of Dravyas is fixed as six; it can never be seven or five (Leaving aside Pudgala Dravya) the others are non-material and formless and hence devoid of all characteristics of matter such as touch, taste, smell and colour.)

Let us now see what other Indian systems of philosophy have to say with regard to the number of Dravyás in the Universe.

In *Tark Samgrah* (तर्क संग्रह), Sutra 2, the following nine Dravyas as the constituent elements of the universe are enumerated:—

"तत्र द्रव्याणिपृथिव्यप्तेजोवाय्वाकाशकालादिगात्ममनांसि नवैव"॥२॥

i. e., पृथिवी, जल, तेज, वायु, आकाश, काल, दिशा, आत्मा and मन these are the nine substances of the Vaisheshika or Kanáda School.

Even a casual glance will show that पृथिवी, जल, तेज and वायु are included in the Jain category of Pudgala Dravya, for the latter has been defined as

"स्पर्श रस गन्ध वर्ण वन्तः पुद्गलाः" ॥ सूत्र २३, अ० ५ ॥

(Material substances are possessed of touch, taste, smell and colour or form)*

Kanáda School regards air (वायु) as without form or colour (तर्कसंग्रह १-१९) but even an elementary student of physics will tell you that scientists have converted air into a *bluish liquid* by continuous cooling just as steam can be converted into water. This is a concrete proof that air has form or colour and is therefore included in the term "matter."

This school regards fire† as devoid of taste and smell and possessing only touch and colour, while air‡ has only the characteristic of touch (See तर्कसंग्रह अ० १ सूत्र २०, ३९.)

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*It should be noted that of these four characteristics of Pudgala Dravya where one exists all exist although in a particular modification of it all of them may or may not be simultaneously detectable by our physical senses. As science is gradually advancing more and more sensitive instruments are being designed and some new property added to the list of properties of various substances. The chief point is that the detection of even one of these four characteristics in any element throws it in the category of Pudgala. None of these characteristics is associated with the other Dravyas of the universe.

†"स्पर्श उष्णस्तेजस्तु स्याद्रूपं शुक्ल भास्वरं।"

‡"अपाकजोऽनुष्णा शीत. स्पर्शस्तु पवने मतः" ॥४२॥

—मुक्तावली—वैशेषिक दर्शन।

The nature of air we have already pointed out. It must possess both taste and smell. And what is after all fire too. The scientists have clearly demonstrated that fire is a material substance. When the energy of molecular agitation in a substance becomes very great, its temperature rises and we get the sensation of fire. It is a form of energy and energy and matter are identical. Hence the characteristics of matter are associated with fire, for fire is composed of material particles raised to incandescence.* Hence fire comes within the fold of Pudgala Dravya.

They regard smell as existent only in earth (पृथिवी). It is true that water, fire or air cannot be perceived by the nose but odour is associated with all these three forms of matter. Human nose is not sensitive enough to detect the smell of these. Several cases are known where our olefactory organ fails; for instance, the cat at once smells of milk or a hound smells of the chase.

Some modern writers have interpreted पृथिवी, जल and वायु as connoting the solid, liquid and the gaseous states of matter respectively. If so, they automatically come within the category of Pudgala.

दिशा (Dishá), *i. e.*, the directions are included in the Jain conception of Akása which is interpreted as

*"Chemists and physicists have taught us that flame consists of incandescent matter, raised to a high temperature by the process of combustion......and that the flame can exist only so long as the combustion goes on and a sufficiently high temperatu e is thereby maintained to render the burning matter luminous.... The flame is the outward visible sign of certain chemical and physical processes, of the action and reaction between the materia which is being burnt and the atmosphere which surrounds it."

—*Outlines of Evolutionary Biology by Dr. Dendy, p. 2.*

mathematically pure space allowing accommodation to the other five Dravyas of the universe; whereas the Vaisheshiks have interpreted Akása as a fanciful stuff something like aether from which sound originates. We shall prove in the following pages that this ın an entirely wrong notion. Coming to the last Dravya मन (Man) which has been regarded as the cause of succession in sensation and thought, we find it in Sutra 18 of *Tark Samgrah* mentioned as a material organ* and hence a form of matter or Pudgala.

We thus see that the nine realities of the Vaisheshiks ultimately reduce to the six substances of the Jain philosophy. Another prominent system of thought Vedànta leaves us with Brahma and Màyà without giving any explanation of Space, Time and Causality. With the help of the mysterious mechanism of Màyà it is not possible to build a world-structure of matter and force.

Our conclusion is, therefore, that the six substances or realities of the Jain thinkers arc (नित्यावस्तिथान्यरूपाणि) permanent in nature and fixed in number as the sole constituents of the universe.

Sutra 5.

"रूपिणः पुद्गलाः" ॥५॥

(Rupinah Pudgalàh).

Also in स्थानांगसूत्र स्थान ५ उद्दे० ३ सू० १ and व्याख्या प्रज्ञप्ति शतक ७ उद्दे० १० we read

"पोग्गलत्थि कायं रूविकायं"—

*See also "*The Hindu Realism,*" p. 93.

i. e., Matter is Rupi, in other words, it has got touch, taste, smell, and colour.

In *Panchastikaya Sar* of Shri Kundkunda we read:

"उपभोग्यमिन्द्रियैश्चेन्द्रियः काया मनश्च कर्माणि।
यद्भवति मूर्त्तमन्यत् तत्सर्वं पुद्गलं जानीयात् ॥८२॥"

(*Tr.*—That which can be perceived by the senses or the sense organs, the various kinds of bodies of living beings, the physical Manas or the brain, the *Karmic* matter are all Murta or Rupi objects. Know that all these are forms of matter or Pudgala.)

Commentary.

In the above gàthà the author points out the various forms of matter. All objects of sense perception have a physical existence; in other words, physical properties such as touch, taste, smell or colour are associated with them. In Jainism five kinds of bodies are enumerated. They are all material and are as follows:

(1) औदारिक शरीर (उदर=womb)—That which is born from the womb, *i. e.*, the organic body of men and animals.

(2) वैक्रियिक शरीर—That which is possessed by the beings of the heaven or those of the hell. It is invisible to normal vision and is capable of transformation in shape or size.

(3) अहारक शरीर—A subtle body which is developed by advanced Yogis and can be projected or shot forth to great distances on special occasions.

(4) तैजस शरीर—The electrical body whose existence has been verified by scientific experiments. (See pages 73-7 ante.)

(5) कार्माण शरीर*—The inner subtle body which is the seed of all mental and physical activities.

Only the first of these can be perceived by senses, the others are subtle bodies, one subtler than the other in succeeding order. But they are all corporeal.

Then the author has included Dravya Mana† (द्रव्य मन) in the class of Pudgala and so it is.

Matter has been divided into six sub-classes as follows :—

"अतिस्थूलस्थूलाः, स्थूलाः, स्थूल सूक्ष्माश्च, सूक्ष्मस्थूलाश्च ।
सूक्ष्मा, अति सूक्ष्मा, इतिधरादयो भवन्ति षड्भेदाः ॥२१॥

*It is this subtle material body which is responsible for keeping the soul bound to the confines of the Universe (the Loka) owing to the gravitational forces of matter surrounding on all sides. When Karmic matte is shed off, the soul, being the lightest substance, moves on upwards until it is brought to rest at the top of the Universe owing to the absence of the medium of motion beyond. This is just in accordance with the physical principles. A hydrogen toy balloon, let free, goes on moving upwa ds owing to the fact that hydrogen is lighter than the surrounding air and comes to rest at the height where the surrounding air is no longer heavier. This view is expressed in Sutras 5 and 6 of Chapter X. "तदनन्तर मूर्ध्वं गच्छत्या लोकान्तात् ॥५॥ पूर्व प्रयोगा दसंगत्वाद्बन्ध-च्छेदात्तथा गति परिणामाच्च ॥६॥

†Dravya Mana appears to be identical with the physiological organ, the Heart.

भूपर्वताद्या भणिता अतिस्थूलस्थूला इति स्कंधाः ।
स्थूला इति विज्ञेयाः सर्पिर्जल तैलाद्याः ॥२२॥

छाया तपाद्याः स्थूलेतर स्कन्धा इति विजानीहि ।
सूक्ष्म स्थूला इति भणिताः स्कन्धाश्चतुरक्ष विषयाश्च ॥२३॥

सूक्ष्मा भवन्ति स्कन्ध प्रायोग्याः कर्मवर्गणस्य पुनः ।
तद्विपरीताः स्कन्धा अति सूक्ष्मा इति प्ररूपयन्ति ॥२४॥

—श्री कुन्दकुन्दाचार्य्य कृत 'नियमसार ॥'

(1) स्थूल स्थूल, *i. e., Solids* such as earth, stone and the like.

(2) स्थूल, *i. e., liquids* like molten ghee (butter), water or oil.

(3) स्थूल सूक्ष्म, *i. e., Energy* which manifests itself in forms of heat, light, electricity and magnetism.

(4) सूक्ष्म स्थूल, *i. e., Gases* like air and others.

(5) सूक्ष्म, *i. e., Fine matter* which is responsible for thought activities and is beyond sense perception.

(6) सूक्ष्म सूक्ष्म *i. e., extrafine matter* such as the streams of single elementary particles, electrons, protons and positrons or of the particles like neutrons which are composed of two elementary particles each, a proton and an electron in close union.

This is the most up-to-date and scientific classification of the kinds of matter. Prior to the discovery of the electron (1876) the physicists and the

chemists divided matter into three main classes, solids, liquids and gases. The advent of the theory of relativity and the elucidation of the nature of the electron necessitated an extensive revision in the conception of matter. It was shown that an electron, which is *the universal constituent of matter*, "is a disembodied atom of electricity free from association with matter as we know it."* To the question "Has energy any weight ?" the classical physics of Newton and Galileo gave a definitely negative answer. "But the theory of relativity gives a very different answer. Energy is not weightless, because it has a definite mass......the deductions from the theory of relativity can be confirmed in a certain indirect way and that the outcome of experiment is definitely in favour of that theory......The quantity of heat required to convert one thousand tons of water entirely into steam would weigh not quite 1/30 of a gram. It is because the mass which energy represents is so small that energy was for so long regarded as a weightless fluid.

The energy of radiation of the sun also represents a certain mass. Millions of tons of energy are scattered every second through the universe."

—*The World in Modern Science, p.* 77.

After pointing out the exact mathematical relation between mass and energy, *viz.*,

$$\text{Energy} = \text{mass} \times (\text{velocity of light})^2$$

the same author proceeds to say that "every mass is a seat of energy ! Not only has energy mass but

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**Magnetism and Electricity* by R. W. Hutchingson, M. Sc., A. M. I. E. E., Vol. II, p. 470.

conversely also every mass has energy......To sum up briefly: the differentiation between energy and mass is discarded. Every mass represents a store of enormous energy and each energy possesses mass, albeit very small."

The author of the *Restless Universe* Professor Max Born has treated this subject beautifully. We quote below from pages 83-86:

"According to this theory (theory of relativity) *mass and energy are essentially the same.** .... .

When a man shoots with a gun he feels a recoil. The bullet flies forwards, so the gun must move backwards—(in a similar way)......emission of light in a certain direction leads to a recoil of the body emitting it. For example, we may take the searchlight and provide it with a shutter. If we open this for an instant, a beam of light rays shoots out Then the searchlight is subject to a recoil like that of the gun.

That this is really so is not just a theory but an experimental fact."

This experiment clearly proves that light possesses weight just as a bullet does. Since light is not like a single shot but a continuous stream, it does not give a sudden impulse but it causes impact on the surface on which it falls just like a jet of water or a blast of wind. It is reported

*According to Jain view the matter and energy are different phases of the same entity called Pudgala—so far unidentified by modern science. The positive and negative forms of electricity must be traced to the same source. Possibly researches in future may prove it.

that with a sufficiently strong light one could knock a man down. Fig. 9 illustrates how the tails
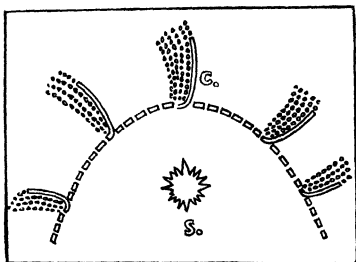
Fig. 9.

The figure shows the tail of a comet continuously veering round so as to be always opposite the sun, thus verifying the Pudgala nature of Light energy.

of comets always point away from the sun. This is because a comet is composed of very minute particles which are blown back by the pressure of the light from the sun.

To quote further from the same book:

"There is no doubt that a body losing energy by radiating light does lose mass; but without necessarily losing particles. The sun loses, in one year, 1,38,00,00,00,0C0 tons by its radiation.

"If light is absorbed by a body, the body becomes warmer and simultaneously heavier by the mass corresponding to the light absorbed. Heat energy, therefore, has mass, just as light energy has.

"Every form of energy storage implies a storage of mass, no matter whether the energy be magnetic, chemical or in any other form. *Energy and mass are just different names for the same thing.... ..*One gram of mass is equivalent to 9×10^{20} ergs; to obtain this energy from coal we should have to burn nearly 3,000 tons. Unfortunately, matter is not sufficiently obliging to set its mass and so, its energy free.

"Recently, however, cases have been found to occur where this transformation of matter into free energy actually takes place."

It is the height of wisdom of Jain thinkers to have included all forms of energy in class of matter. In fact they have identified matter and energy under the general name Pudgala. One form of energy can be changed into another form because they are fundamentally the modifications of the same Dravya Pudgala. This intra-convertibility of heat into light, light into sound, sound into electricity and so on is the secret of all wonders of modern science. One example of the recording and reproduction of talking films will illustrate this point.

The microphone which hangs over the head of an actor in the studio converts the sound waves into electric current; this current is then passed through a special lamp where the electric current is changed into light. This light falls on the film and gives rise to what is known as the 'sound record.' Notice the changes : sound into electricity and electricity into light.

In order to reproduce the sound from the film, the reverse process is adopted. Light

transmitted through the sound record falls on a "photo-electric cell" which changes light into a current of electricity and this current after passing through a loud-speaker generates the original sound. Notice the changes again: light is converted into electricity and electricity into sound.

The physicists have regarded all forms of energy as one substance and just as a sugar toy in the form of an elephant can be easily converted into another apparently divergent form of a palace, in the same way instruments have been devised by scientists to convert one form of Pudgala into another form. In no other system of Indian thought this beautiful concept of Pudgala (energy and matter) exists

Let us now take up one interesting point which may seem curious and incomprehensible. The Jain thinkers have included shadows and images formed by lenses and mirrors* in the स्थूल सूक्ष्म class of Pudgala *i. e.* they regard it as a manifestation of energy, (*Vide p* 83 *ante.*) The formation of shadows is explained by the physicists as follows:—

An opaque obstacle in the path of the rays of light casts a shadow because the rays are obstructed and are unable to enter the region of the shadow. The images formed by lenses and mirrors are of two kinds called virtual and real. The example of a virtual image is the image seen in a looking glass, whereas the example of the latter is the images on a cinema screen. In the case of a virtual image the rays appear

*"छाया प्रकाशावरण निमित्ता, सा द्वेधा, वर्णादि विकार परिणता प्रतिबिम्ब मात्रात्मिका चेति," -सवार्थसिद्धि अ० ५ सू० २४॥

to come from the image whereas in the case of a real image the rays do actually come from it. Thus it is clear that energy *manifests* itself in the form of shadows and images, virtual and real.

Also there is evidence to show that a dark space is not entirely devoid of energy. We read on p. 137 of the *Restless Universe*:

"Instead of looking at a system of interference bands* with the eye, it is possible to make a small counting apparatus pass over them and count the electrons photo-electrically liberated by them in the tube. Then we obtain many electron impacts just when the counting tube is over a bright band, and *few when it is over a dark band.*"

With regard to the sound energy the Jain thinkers have included it in the सूक्ष्म स्थूल class of Pudgala because it cannot be seen with the eyes but can be perceived with the help of the auricular organ, whereas the shadows are included in the class स्थूल सूक्ष्म. It should be noted, however, that the two classes are overlapping as do their names. Prof. A Chakravarti observes in this connection as follows:

"Unlike the other Indian systems of thought which associate sound with Akāsa Jain system explains the sound as due to the violent contact of one physical object with the other. It is said to be generated by one skandha (molecule) knocking against another skandha Sound is the agitation set up by

* When one wave of light energy interferes with another under certain conditions, alternate bright and dark bands are formed called *interference bands*.

this knock. It is on account of this theory of sound that the system speaks of an atom or Parmánu as ***unsounding by itself.*** " p. xxxviii. This idea is expressed in gàthàs 85 and 86 of *Panchastikaya Sar*.

"आदेश मात्र मूर्त्तः धातु चतुष्कस्य कारणं यस्तु ।
सज्ञेयः परमाणुः परिणाम गुणः स्वयम शब्दः ॥८५॥
शब्दः स्कन्धप्रभवः स्कन्धः परमाणु संघ संघातः ।
स्पृष्टेषु तेषु जायते शब्द उत्पादको नियतः ॥८६॥

The atom is defined as having a perceptual form, the cause of elements like earth, fire, water and air and *unsounding*. The cause of sound natural or artificial has been pointed out to be the striking of molecules against one another.

This is just the scientific view of the generation of sound. 'Sound does not travel in vacuum' is a famous experiment which is shown to every schoolboy. If sound were generated by Akàsa or Ether as is supposed by the author of the Vaishesik School, sound would be still heard for æther or Akàsa is present in the vacuous space also.

The view of science is expressed by R. S. Willows in his *Text-book of Physics*, p. 249.

"It is a common experience that a source of sound is in a state of vibration. For example, the prongs of a tuning-fork, a bell, the strings of a piano and the air in an organ pipe are all in a state of vibration when they are producing sound."

Again on page 261 : "Light waves can travel through vacuo but sound waves require a material medium."

We now take up the discussion of another form of Pudgala known as *Karmic* matter. It is regarded as a subtle form of matter which is drawn in towards the soul as a result of our desires, passions and other thought activities. It is well-known that our thoughts and deeds affect our character and modify the tendencies of our souls. Therefore *Karma* should be regarded as some form of vital force, for it would be quite illogical to think that the soul could be influenced by something which has no substantiveness. Since force is unthinkable apart from matter, Kármic matter has been regarded as the agent through which our thoughts and actions affect the soul.

The existence of Kármic matter is partly established by the recent investigations of scientists in America. We reproduce below certain portions of the reports* recently presented before the Federation of American Societies for Experimental Biology:

"The activities of mind and matter constitute a super-radio, with the quintillions of living cells sending out their individual waves to be tuned in by quadrillions of receiving sets in the brain......Professor Hallowell Davis of Harvard Medical School described five different kinds of waves that have now been found to be emanating from the brain.....*The encephalogram*

*In the issue of the "Discovery" (London) for December 1937 the apparatus for measuring brain-waves has been described as a valve amplifier "which is regular during normal thought but erratic if any sudden shock disturbs the mind. Mr. Grey Walters has found it possible with this apparatus to measure the normal and abnormal intensity of thought—"

—*Recent Advances in Biophysics by* F. W. Britton, D. Sc.

(electrical record of the brain-waves on paper) *taken under standard conditions seems to be quite characteristic for a given person......* The brain and nerves, stated Professor Davis, generated electrical waves which could be detected by means of sensitive amplifiers*..
....

That the *body's electrical impulses are connected with a chemical activity*, the electrical impulses being associated with the secretion by the nerve-endings of a powerful drug known as acetylcholine, was brought out in a paper by Dr. V. E. Henderson of the Department of Pharmacology, Toronto University. It was for work in this field that Professor Otto Loewi of Graz, Austria, and Sir Henry Dale of London received the Nobel Prize in medicine last winter.

Professor Leo Loeb of the Department of Pathology, Washington University School of Medicine, St. Luis, presented a paper on the "Biological Basis of Individuality". He offered evidence for the existence of substances in each individual higher organism, man as well as animals and birds, which bring about the unification of its many parts.

"These 'individuality differentials' are genetically determined and therefore transmitted by heredity but they are represented by substances which develop in the course of phylogenetic and embryonal evolution," said Dr. Loeb.

These reports of the American doctors establish the fact that our thoughts and emotions give rise to

*Reproduced from "Hindustan Times," July 3, 1937. William L Laurence's article under the caption "Man's Mind Traced by Electricity"

electrical waves in the brain which tune in foreign energy waves just as the waves generated in a radio-receiving set tune in electrical waves of foreign stations. This is what a Jain would call Ashrava (*i. e.*, influx) of Kàrmic matter into the soul. That the influx of these electric impulses is connected with chemical activity is a clear index of the fact that our Karmas accumulate round the soul in the form of fine dust. Thus the existence of Kármic matter is to a very great extent established by experimental science.

The extra-fine matter सूक्ष्मसूक्ष्म we have interpreted as streams of indivisible elementary units of matter called electrons, protons, positrons and neutrons of modern science. The reason for this is this:

"अत्यंत सूक्ष्माः कर्मवर्गणाभ्योऽधो द्वयणुक स्कंध पर्य्यंताः सूक्ष्म सूक्ष्म इति।"

The extrafine matter has been said to be composed of skandhás made up of *one or two Parmanus and no more*, and a *Parmanu* has been defined as

"जद्दव्वं अविभागो तं परमाणु विआणे हि"

—सर्वार्थसिद्धि टीका, सूत्र २५

(The last particle of matter, which cannot be sub-divided any further by any means whatsoever, is a Parmánu)

Also in Sutra 27 of *Tattvartha Sutra* Ch. v. we have

"भेदादणुः"—(भेदात् अणुः उत्पद्यते)

i. e., A Parmánu is obtained by division of matter to an infinite extent, not by union.

Or from तत्वार्थ राजवार्तिकः "ततोऽल्प परिमाणा भावात् ॥५।१।१।२॥ There is nothing smaller than Parmánu.

It follows that a Parmánu cannot be interpreted and should not be interpreted as the *atom of modern chemistry,* although originally the word was invented by the Greek philosopher Democritus (420 B. C.) to denote something which could not be sub-divided (atom—α, not; τεμνω, I cut.) John Dalton, the great propounder of the Atomic Theory of matter, declared in the year 1808 "Thou knowest no man can split atom." But since the atom of chemistry has now been proved to be a conglomeration of protons, neutrons and electrons, I venture to suggest that Parmánus are really these elementary particles which exist by themselves, or if at any future date a sub-electron were to be discovered that should then be interpreted as the Parmánu of the Jains. Neutron* is composed of two Parmánus and hence included in the category of extra-fine matter.

Before concluding the commentary on this Sutra it would be well to quote the Sánkhya view of matter. Against the declaration of the Jains "रूपिण पुद्गला:" the

*The extra-fine character of the neutrons is exhibited in the fact that they cannot be kept confined in a vessel of glass, metal or rubber. They slip through the walls of the vessel. Their velocity is about 1,000 miles per second. They can penetrate a mile's thickness of air and several feet of lead, which even X-rays cannot. Their piercing power is so great that, according to one scientist, if a cannon ball could be made out of them it would pierce 75 million miles of steel plate They have been found to be a powerful weapon in the artificial breaking of Skandhas. Neutrons exist in the air we breathe only one part in 160,000,000,000. Neutrons are produced when aluminium is bombarded by alpha particles from radio-active substances

Sánkhya school regards Prakriti or Nature as arupi (अरूपी).

"The manifested world is traced to an unmanifested ground, the Prakriti, which is conceived as formless, and undifferentiated, limitless and ubiquitous, indestructible and undecaying, without beginning and without end. The unit of this *prakriti* is a mere abstraction; it is in reality an undifferentiated manifold, an indeterminate, infinite continuum of infinitesimal Reals."

—*Introduction to Hindu Chemistry* by Sir P. C .Ray.

This view is quite in conformity with the fact that ultimately all kind of matter and different forms of energy are reducible to a single form of Pudgala, the invisible fundamental particles of electricity electrons, protons, positrons and neutrons being the extra-fine (सूक्ष्मसूक्ष्म) form of it. Though these particles are invisible to the eyes, they can be perceived by other means and also give rise to concrete form of matter. Hence Jain thinkers have said "रूपिणपुद्गला:".

Sutra 6.

" आ आकाशादेक द्रव्याणि " ॥६॥

A Akása-deka-dravyáni

=(आ आकाशात्-एकद्रव्याणि भवन्ति)॥

Also in *Uttradhyayan Sutra* ch. 28 gáthá 8 we read

" धम्मो अधम्मो आगासं दव्वं इक्किक माहियं "

Referring to the first sutra "अजीवकाया धर्माधर्माकाश पुद्गला:" the author says that the Dravyas enumerated

there up to Akàsa (*i.e.*, Dharma, Adharma and Akása) are one continuum each *i. e.* indivisible wholes.

The earliest recognition of the motive principle called Dharma Dravya in found is the Jain literature alone but ancient Greek philosophers also recognised its necessity in the scheme of the universe. Anaxagoras in his work *On Nature* (450 B. C.) introduced for the first time in the Western world the idea of a medium necessary for motion and called it νους (the cause of all changes): Aristotle, called it αιθηρ (æther)*. In the standard work of Dr. J. W. Mellor, quoted before, we read as follows :—

"Aristotle added a fifth element, æther, more divine than the others (earth water, air and fire) and which pervaded all things and was in perpetual motion.......The ancient Hindu philosophers also had a fifth element, which, in their system, was *wrongly supposed to be a medium for propagating sound*, etc., and which, in consequence, *had something in common with the modern concept of an aether pervading all space*" (p. 33).

The non-atomic continuous nature of æther has been recognised by science in the following words:—

"Ether is not composed of atoms If it be supposed that it consists of minute homogeneous atoms, it must be further supposed that there is something else between these atoms, either 'empty space' or a third compl tely unknown medium, a purely hypothetical 'inter ether'; the question as to the nature of this brings us back to the original difficulty, and

*See "Greek Thinkers" by T. Gompertz, London, and also "Early Greek Philosophy" by J. Burnet, London.

so on ad infinitum. As the idea of an empty space and an action at a distance is scarcely possible in the present condition of our knowledge........I postulate for ether a special structure which is not atomistic, like that of ponderable matter."

—*The Riddle of the Universe* by Prof. Hæckel, Chap. xii.

"Huyghens introduced the conception of the æther—a weightless, transparent medium which permeates the entire universe."

—*The World in Modern Science*, Infeld, p. 30.

"At the time when that conception (that of electric fluid) arose, it had become the fashion to introduce into science, in addition to matter of different kinds which possessed weight, substances which one might call imponderable,—*i. e.*, weightless fluids. Heat, electricity, magnetism and the ether were some of the members of this imponderable family. *Nowadays, the ether is the only member of this family which has survived,........*"

—*Ibid. p.* 68.

"Material media are penetrated by æther, their molecules being surrounded by it much as the leaves of a tree are surrounded by the air."

(For more details about æther read pages 25-31 *ante.*

These quotations establish the nature of ether as a non-atomic continuous medium.

We have already shown that the modern science has postulated the existence of gravitation in order to account for the stability of the macroscopic world and the existence of similar electromagnetic forces in the case of the micros-

copic world like that of the atoms and the molecules. Those who are in touch with the recent developments in Physics know that the great physicists like Prof. Einstein are trying to formulate a satisfactory theory *which will combine the forces of gravitation and electromagnetism into one unified whole.* Several theories are in the field at present and one which will be found convincing in all respects will be accepted. Then we will be left with one Adharma Dravya, the principle of stability for the macroscopic as well as for the microscopic world.

In the meantime let us see what is the present view of science on this point. As mentioned on p. 44 the physicists have at every step felt the necessity of assuming a medium for the operation of gravitation but they never formulated it in clear words. However in the case of electromagnetic forces, which are a counterpart of gravitation, a medium was recognized by the great "Prince of experimenters" Sir Michiel Faraday and the same conception is still in force. Writing on p. 140 of the *Restless Universe* Prof. Max Born states that "at the beginning of the 19th century most physicists, particularly on the continent, asserted that the electric force acts through the empty space between two charges ("action at a distance"). Faraday, however, developed the idea that the electric field is due to something which happens in the space between the charges ("action through a medium")."

With regard to the continuity of space the space of the mathematician of to-day is undoubtedly an unbroken continuum; even the dictionary meaning of 'space' conveys the same idea. The Standard Oxford

Dictionary defines space as a "continuous extension viewed with or without reference to the existence of objects within it."

(For more details read pages 48-57 *ante.*)

It is thus evident that Dharma, Adharma and Akàsa are indivisible extensions as mentioned in the above Sutra.

Sutra 7.

"निष्क्रियाणि च" ॥७॥

Nishkriyáni cha =(आ आकाशत् निष्क्रियाणि च भवन्ति)

(Dharma, Adharma and Akása, these three are not capable of moving from one place to another.)

Not only these three but also the Time is incapable of motion. (कालस्यापि सक्रियत्वमिति चेन्न——— सर्वार्थसिद्धि टीका, सूत्र ७ ॥)

The learned author of *Sarvarthasiddhi* has raised a very interesting point in the commentary on this Sutra. He says:

"धर्मादीनि द्रव्याणि यदि निष्क्रियाणि ततस्तेषा मुत्पादो न भवेत।
उत्पादा भावाच्च व्ययाभाव इति ॥"

(*Tr.*—If Dravyas, Dharma, etc., are incapable of motion from place to place how is Utpád and Vyaya maintained which is the chief characteristic of a substance). (See pages 65-66 *ante*). From the very nature of definition of a substance it follows that generation (Utpâd) and decay (Vyaya) must go on in these Dravyás in some form or the

other. The same author answers the point saying:

"अनन्तानाम् अगुरुलघु गुणानामागम प्रामाण्यादभ्युपगम्यमानानां षट्स्थान पतितया वृध्या हान्या च प्रवर्तमानानां स्वभावादे तेषा मुत्पादो व्ययश्च ॥"

Amongst the six common attributes of substances, *viz.*, अस्तित्व (Indestructibility), वस्तुत्व (functionality), द्रव्यत्व (changeability), प्रमेयत्व (capacity of being the subject of knowledge), अगुरुलघुत्व (Individuality) and प्रदेशत्व (capacity of having some form) the Agurulaghu (अगुरुलघु) attribute is such that an imperceptible rythmic rise and fall is constantly taking place in its parts in *six different steps* and these natural rythms rising and decaying produce Utpáda and Vyaya. Agurlaghu attribute is said to be responsible for maintaining the individuality of the substance and its characteristic properties. The षट्गुणी हानि वृद्धि or six different steps of infinitesimal changes,—an entirely ingenious idea of the Jain thinkers,—can be explained as follows :—

Enumeration has been divided into three classes: (*i*) संख्यात, countable; (*ii*) असंख्यात, countless, and (*iii*) अनन्त, infinite

To explain the full meaning of these three classes with their 21 sub-divisions is a long mathematics and would carry us far beyond the present theme. It is enough to mention the distinction between countless and infinite The former has a limit, though it is beyond the power of even an omniscient being* to count

* "संख्या विशेषातीत तत्वादसंख्येया:"
"तदनुपलब्धेर सर्वज्ञत्व प्रसंग इतिचेन्न तेनात्मना वसित्वात् ।"
—तत्वार्थ राजवार्तिकम् ।५।८।१।२।

them, the latter is inexhaustible and without limits. To give an example, the number of unitary cells of space (pradeshás) in Loka is countless since Loka is finite but the number of pradeshás in the space beyond is infinite, since Aloka has no limits.

The six steps upwards are: (*i*) Infinitesimal increase,* (*ii*) increase by a countless fraction, (*iii*) increase by a countable fraction, (*iv*) increase countable times, (*v*) increase countless times, (*vi*) increase infinite times. (Note that these steps are in ascending order of magnitude.) The six steps along the descent are in exactly reverse order so that the whole series of changes constitutes, what in science we call, *a reversible cycle*. The hypothetical numerical example given below will make the point more clear:

Suppose there is a number 1024; let the countable, the countless and the infinite be represented respectively by 2, 4 and 8; then the number will undergo the rise and fall like this:

(*i*) Infinitesimal increase: $1024+\frac{1024}{8}=1152$

(*ii*) Countless fraction increase: $1152+\frac{1024}{4}=1408$

(*iii*) Countable fraction increase: $1408+\frac{1024}{2}=1920$

(*iv*) Countable times increase: $1920+(1024\times 2)=3968$

(*v*) Countless times increase: $3968+(1024\times 4)=8064$

(*vi*) Infinite times increase: $8064+(1024\times 8)=16256$

*In the language of calculus it means increase from x to $x+\delta x$.

In Swetámbar text this Sutra has been broken into two:

"असंख्येयाः प्रदेशा धर्माधर्मयो." ॥ ७ ॥

"जीवस्य च" ॥ ८ ॥

Also in स्थानांग सूत्र स्थान ४ उ० ३ सूत्र ३३४ we have

चत्तारि पएसग्गेणं तुल्ला असंखेज्जा पण्णत्ता, तं जहा,—
धम्मत्थिकाए, अधम्मत्थिकाए, लोगागासे, एगजीवे"॥

(*Tr.*—There are countless Pradeshás* in Dharma, Adharma and a single soul.)

The same idea is expressed in *Tattvarth Sar*

"एकस्य जीवद्रव्यस्य धर्माधर्मास्ति काययो
असंख्येय प्रदेशत्वमेतेषां कथितं पृथक्" ॥ ३,१९ ॥

Or in *Niyamsar* gáthá 35.

"धर्माधर्म्मयोः पुनर्जीवस्यासंख्यात प्रदेशाः खलु ॥"

(There are countless points of space in the medium of motion, medium of rest and in each individual soul.)

Pradesh is the unit of three-dimensional space which is employed in the measurement of the dimensions of the substances in the universe Taking this as the measure the number of Pradeshás in the universe is said to be countless. The media of motion and rest are co-extensive† with the universe

*For definition of Pradesha and its full explanation see pages 4-18 *ante*.

†लोकाकाशे समस्तेऽपि धर्माधर्मास्ति काययोः ।
तिलेषु तैलवत् प्राहुरवगाहं महर्षयः ।" —तत्वार्थसार ॥३, २३॥

(Dharma and Adharma pervade all parts of the universe as oil pervades the whole portion of a mustard seed.

(लोकाकाश) and have thus a similar number of Pradeshás. Souls are found in different bodies of different dimensions in their mundane state but each one of these has the capacity of expanding and filling the whole universe.* Thus the number ot Pradeshás in each soul is equal to the number of those in the universe, *i. e.*, countless or innumerable.

It should not be thought at this stage that the mention of a number of Pradeshás in the universe as countless introduces an uncertainty with regard to the size of the universe. Although Dharma, and Adharma are continuous media, it is only for explaining certain physical and psychical phenomena that this idea of parts is introduced. The Jain thinkers have given a definite figure for the volume of the universe; 239 cubic Rajjus,† according to Swetámbars and 343 cubic Rajjus, according to Digambaras.

*"संहाराच्च विसर्पाच्च प्रदेशानां प्रदीपवत ।
जीवस्तु तद संख्येय भागादीनवगाहते ।"—तत्वार्थसार॥३, १४॥

(By contraction and expansion of its Pradeshas a soul is capable of occupying the countless Pradeshas of the universe, just like the flame of a lamp whose light can fill either a small room or a big hall)

† Rajju (=chain, a linear astrophysical measure), is, according to Colebrook, the distance which a Deva flies in six months at the rate of 2,057,152 yojans in one क्षण, *i. e.*, instant of time

—*Quoted by Von Glassnapp in "Der Jainismus."*

Compare this unit with the modern unit of astronomical distances, *viz.*, the light-year which hasbeen defined as the distance which a beam of light travels in one year at the rate of 186,000 miles per second. Is not the similarity very striking ?

It would not be out of place here to give an idea of the "Countless" as enunciated by Jain writers. Suppose there is an interminable series of oceans and continents surrounding each other on the flat earth in the form of concentric rings with a minimum diameter of 100,000 yojans (one yojan = 4,000 miles), which goes on doubling itself in the case of each succeeding continent and sea. Let there be four pits A, B, C, D each 1,000 yojans deep and of the diameter of the smallest continent, *viz.*, 100,000 yojans. If the pit A is filled with mustard seeds up to the top and above it in conical formation, calculation shows that the pit will hold 197,711,293,845,131,636,363,636,363,636,363,636,363,636,363,6 $\frac{4}{11}$ seeds of mustard.

Suppose we empty this pit by dropping one seed in each of the continents and oceans, which, as have supposed, form an interminable chain At the place where the last seed is dropped we dig another pit 1,000 yojans deep, as before and of the diameter of this ocean or continent, whatever it be and fill it to the top as before. Empty this pit again in the same manner beginning with the continent or ocean next to one in which this pit is situated Stop where the last seed is dropped and dig a pit of the same depth as before but of the diameter of the ocean or the continent itself. Remember that the diameter is doubling as we go to the succeeding ocean or the continent. This process will be continued until the pit D is filled in the manner indicated in the next paragraph. Let the pits dug so far be called the pits of A series.

Each time that a pit of A series is dug one mustard seed must be thrown in B until the latter

is full to the top as indicated in the case of A. When this is achieved, the same process of traversing the continents and oceans of ever-increasing diameter and digging the pits is to be continued. Let the pits now dug be called the pits of B series. Each time that a pit of B series is dug one seed must be thrown into the pit C. The whole process is to be repeated until the pit D is filled. Let the number of seeds in the last pit of C series when D is full be represented by x

Then $(x^x)^2$ is called the Minimum Ultimate Countless. The Maximum Ultimate Countless is Preliminary Infinity minus one The idea of infinity is given in connection with Sutra 9.

Sutra 9.

"आकाशस्यानन्ताः" ॥ ९ ॥

Akáshasyá-nantáh.

= (आकाशस्यानन्ताः प्रदेशा सन्ति ।)

"आगासत्थिकाए पएसट्ठयाए अणत गुणे"।

—प्रज्ञापना पद ३, सूत्र ३१ ।

(*Tr.*—The number of Pradeshás in Space is infinite.)

The conception of Infinity, according to Jainism, is as follows:

Raise the quantity $(x^x)^2$ to its own power; then raise the result so obtained to its own power and repeat this process $(x^x)^2$ times. Let the final number be denoted by x_1

Again raise x_1, to the power x_1, and the result obtained to its own power and continue the process

$(x_1^{x_1})$ times. Let the number now obtained be denoted by x_2.

Repeat the whole operation a second time, *i.e.*, $(x_2^{x_2})$, then $(\text{Result})^{\text{Result}}$ to be con inued $(x_2^{x_2})$ times. Let the result be now denoted by x_3.

Again $(x_3^{x_3})$, then $(\text{Result})^{\text{Result}}$ to be continued $(x_3^{x_3})$ times Suppose it gives the number x_4

The process of arriving at x_4 from x_1, is given the technical name शलाकात्रय निष्ठापन (Shalákátraya nishthápan). Since we shall have to resort to this process several times in reaching the Infinity, we shall for the sake of simplicity call it the S T N. process. To x_4 add the following numbers

(1) Countless Pradeshás of Dharma Dravya

(2) ,, ,, Adharma Dravya.

(3) ,, ,, a single soul in fullest expansion, *i e*, filling the whole universe.

(4) Countless Pradeshás of Space occupied by Loka, *i. e.*, excluding Aloka.

(5) The number of souls in ordinary vegetation which is innumerable times greater than the number of Pradeshás in the Loka.

(6) The number of souls in vegetable parasitic groups which is countless time greater than the number in (5).

Let the number obtained after addition of these six quantities be denoted by $(x_4 + a)$

Subject the number to S. T. N. process and let the result be denoted by x_5.

To the number x_5 add the following :—

(1) the countless number of moments in a cycle of time. (Cycle of time is explained in Sutra 39);

(2)* the countless modifications of consciousness;

(3) the innumerable degrees of intensity of passions;

(4) the still innumerably greater number of soul vibrations associated with the activities of the mind, speech and the body.

Let the sum be denoted by (x_5+b).

Subjecting (x_5+b) to S. T. N. process, suppose we get x_6. (This number is called Preliminary Infinity.)†

Let $(x_6)^{x_6}$ be denoted by x_7 and

$$\left\{ (x_7)^{x_7} \right\}^{(x_7)^{x_7}} \quad \text{by } x_8.$$

Subject x_8 to S. T. N process and let the result be x_9.

To x_9 add the following quantities :

(1) The number of souls which has attained Nirvána; this number, although infinite, is infinitely smaller than the total number of souls in the universe.

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* For details of (2), (3) and (4) read *Gommat Sar Jivakanda*, by J. L. Jaini, S. B. J., Vol. V.

† x_6 minus one is "Maximum ultimate countless." See page 107 *ante*.

(2) The number of undeveloped souls (akin to bacteria and unicellular organisms of modern biology) which is infinitely greater than the number in (1).

(3) The number of vegetable souls again infinitely greater than the number in (1).

(4) Number of atoms of matter, which is infinitely greater than the total number of souls.

(5) The number representing the moments of time, infinitely greater than the number of atoms of matter.

(6) The number of points of space, again infinitely infinite.

Let the sum be denoted by (x_9+c).

Subject (x_9+c) again to S T N. process and denote the result by x_{10}

To x_{10} add ·

(1) The infinitely infinite shades* of qualities of Dharma Dravya, and

(2) ditto for the Adharma Dravya.

Let the sum be denoted by $(x_{10}+d)$

Subjecting this number to S. T N process we arrive at infinity, for which the mathematical symbol is ∞.

This infinity of Jainás comprises the infinite existing substances and their compounds as well as their infinite states and modifications, and is therefore the 'true' infinity.

* It is the change in these shades which has been referred to in pages 100-103 *ante*.

Sutra 10.

"संख्येयाऽसंख्येयाश्च पुद्गलानाम्" ॥१०॥

Sankhyeyásankhyeyáshcha pudgalánám.

=संख्येयाः असंख्येयाः च (अनन्ताः अनन्तानन्ताः) पुद्गलानाम् प्रदेशाः भवन्ति ॥

(*Tr.*—Matter consists of numerable, innumerable and infinite parts according as we consider the different molecular combinations.)

Evidences from other sources may be quoted:

"मूर्ते त्रिविधा प्रदेशा"

—द्रव्यसंग्रह गाथा २५ संस्कृत वृत्ति.

(Pudgala has pradeshás which are numerable, innumerable and infinite.)

"संख्यातासंख्यातानंत प्रदेशा भवन्ति मूर्तस्य" ॥३५॥

—कुन्दकुन्दाचार्य कृत 'नियमसार'

The scientific division of Pudgala is as follows:

(1) Concrete and (2) Invisible.

The concrete form we call Matter and the invisible form, Energy.

Matter is further divided into solids, liquids, and gases. All these three forms of matter consist of molecules (Skandhás) and atoms (Skandh-deshás)*.

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*स्कन्धाश्च स्कन्धदेशाः स्कन्धप्रदेशाश्च भवन्ति परमाणवः इति ते चतुर्विकल्पाः पुद्गल काया ज्ञातव्याः ॥८०॥

—पंचास्तिकायसार ।

(Matter is composed of molecules, atoms, ionised atoms and invisible elementary particles, such electrons, protons, positrons and heavy electrons of modern science)

For 'ionised atoms' read page 15 *ante*. Heavy electron, which is 50 times heavier than the ordinary electron, is a recent discovery. (*Science and Culture*, November, 1937.)

Atoms are again an assemblage of indivisible elementary particles (परमाणव:), protons and electrons and their combinations The number of electrons in the universe has been estimated by Professor Einstein to be

12900000000000000000000000000000000000000000000000000000000000000000000000000000

(*i e* , 129 followed by 77 ciphers or 80 digits in all.)*

Now this is a finite number although very huge. The number of other elementary particles has not been estimated. Then there are the condensed forms of matter, such as those referred to in pages 16–17 *ante* –the nuclear matter as it is called weighing 620 tons to a cubic inch—in which there is an extremely close packing of particles beyond human estimation. Then there are electrons of negative mass (see page 123) which do not in any way betray their existence; those which have retired for good from the drama of the universe and whose presence cannot be detected by any measurements whatsoever, thus rendering it impossible to count their number. So the author of the Sutra says: the number of parts into which matter and energy is divided may be finite or infinite according to different considerations.

There seems to be an apparent contradiction between this and the 8th Sutra The latter says that the number of Pradeshás (Spatial units) in the media of motion and rest is only countless whereas according to the present Sutra the number of Pradeshás in Pudgala Dravya may be

* Quoted from the Presidential Address of Professor A. S Edington to the Physical Society of London and published in the Proceedings of the Society, January 1932

infinite. As has been mentioned several times the media of motion and rest (Dharma and Adharma) are co-extensive with the Loka, the universe. Hence the number of Pradeshás in the universe also is "countless." The question therefore arises: "How can an infinite number of pudgala particles be accommodated in 'countless' pradeshás of the universe ? The question would have been quite valid if all the infinite particles were in a free state but it is not so. A tiny piece of fuel on combustion gives rise to an enormous volume of smoke particles, a quantity of water when converted into steam occupies a volume about 1,700 times greater than the original volume, a saccharin pill compresses within itself the particles of sweetness which several lumps of sugar would possess, the pollen concentrates in itself the particles of fragrance which occupy a very large volume when they fly in space. And above all there is the tremendous concentration of stripped atoms which gives rise to 'nuclear matter.'

Hence the above contradiction does not arise.

Sutra 11.

नाणोः ॥११॥

Nánoh.

= नाणोः प्रदेशा भवन्ति

(There are no numerable pradeshás of an indivisible elementary particle of matter.)

An indivisible elementary particle of matter, which is wrongly designated by the word 'atom,'

always occupies one unit of space. It follows from the definition of Spatial unit (Pradesh) itself. (See page 4 *ante*). The author of सर्वार्थसिद्धि gives the reason. He says:

"अणोरल्पीयानन्योऽस्ति"=नहि अणोः अल्पीयान् अन्य अस्ति ।

There is nothing smaller than an *anu* (अणु). It is for this reason that the space occupied by an *anu* is called the Pradesha.

Sutra 12.

"लोकाकाशेऽवगाहः" ॥१२॥

Lokákáshevagáháh.

=धर्मादिनाम् द्रव्याणाम् लोकाकाशे अवगाहः ॥

(These substances Dharma, Adharma, Jíva, Ajíva, etc., exist only in Lokákásha.)

"धर्माधर्मौ कालः पुद्गल जीवाः च सन्ति यावतिके ।
आकाशे स लोकः ततः परतः अलोकः उक्तः" ॥२०॥

—द्रव्यसंग्रह संस्कृत वृत्ति ॥

(Lokákásha is that in which Dharma, Adharma, Kála, Pudgala and Jíva exist. That which is beyond this is Alokákásha).

"सर्वेषां जीवाना शेषाणां तथैव पुद्गलानां च
यद्ददाति विवर मखिलं तल्लोके भवत्याकाशं" ॥९.७॥

—पंचास्तिकायसार ॥

(That which accommodates all matter, the souls and the remaining substances is the Lokákásha). Also in Swetambar Sutrás we have:

"धम्मो अधम्मो आगासं कालो पुग्गल जन्तवो ।
एस लोगोत्ति पण्णत्तो जिणेहिं वरदंसिहिं" ॥

—उत्तराध्ययन सूत्र, अ० २८, गाथा ७.

This division of infinite space into Lokákásha and Alokákásha, i. e., Universe and Non-universe is based on the Dravyás Dharma and Adharma. Souls and matter move on and rest up to the confines of the Universe only. Beyond this the media of motion and rest are absent This determines the limit of the finite universe. The Alokákásha is an infinite space without any soul or a particle of matter and it surrounds Lokákásha on all sides.

The following brief description of the Lokákásha may be given

The Loka, i. e., the universe is supported in the middle of the Aloka in the form of a human trunk with Siddha Shila (सिद्ध शिला) at the top where head should be. The surrounding zones of air in which the universe is floating are said to be three, the inner zone being humid, the middle dense and the outer of rarefied gases. The Siddha Shila, the abode of Perfected Souls, is the summit of the universe in the form of a bi-meniscus convex lens with its concavity downwards. The universe is divided into three big divisions, the upper world, the middle world, and the lower world. They are situated one above the other and are inhabited by

celestial beings, worldly creatures and the hellish beings, respectively.

The total volume of Loka, according to Digambar text is 343 cubic rajjus,* and according to Swetambarás 239 cubic rajjus. One definition of rajju is given in the footnote on p. 105. There is another, quoted by Pt. Mádhavácháryá, Research Scholar, in the "Anekánt", Vol. 1, 3:

एक हजार भारं का लोहे का गोला इन्द्रलोक से नीचे गिर कर ६ मास में जितनो दूर पहुंचे उस सम्पूर्ण लम्बाई को एक राजू कहते हैं।

Tr.—Rajju is the distance travelled in six months by a ball of iron weighing 1,000 *bhar* (probably tolás; 1,000 tolás=12·5 seers or kilograms) let fall freely from Indraloka (the abode of heavenly beings).

This definition cannot be subjected to computation since the law of fall of bodies from Indraloka is not known. It appears that in Indraloka the rate of fall depends upon the size of the body and then nobody can say what the uniform acceleration would be. However if we take the Einstein's value

*In the standard work on astronomy "Triloksár" of Nemichandra Siddhánta Chakravarti we read in Gáthá 3. "सर्वाकाशमनंतं.. जगच्छ्रेणि घन प्रमाणो हि", i. e, the cube of Jagatshreni (जगच्छ्रेणि) is the volume of the Loka and Jagatshreni in terms of rajju is defined in Gáthá 7 as "जगच्छ्रेणि सप्तम भागः रज्जूः", *i. e.*, 1/7th of Jagatshreni is rajju or Jagatshreni is equal to 7 rajjus. Therefore cube of Jagatshreni is cube of 7 rajjus Hence the volume of the Universe is $7 \times 7 \times 7 = 343$ cubic rajjus.

It should be noted that this gives us another definition of rajju in terms of Jagatshreni but since the latter has been said to be of countless Maháyojans it cannot be subjected to a mathematical computation.

of the radius of the finite universe we can arrive at the order of magnitude of a rajju thus :

Radius of the universe = 1,068 million light-years

One light-year $= 5{\cdot}88 \times 10^{12}$ miles

$\therefore$ Volume of a spherical universe, *i. e.*, ($\frac{4}{3}\pi r^3$)

$= \frac{4}{3}\pi (1068 \times 10^6 \times 5{\cdot}88 \times 10^{12})^3$ cu. miles

$= 1037 \times 10^{63}$ cu. miles

i.e., 1037 followed by 63 ciphers or 67 digits in all.

Now if $1{,}037 \times 10^{63}$ be equated to 343 cu. rajjus, we get

One rajju $= 1{\cdot}45 \times 10^{21}$ miles,

whereas if equated to 239 cu. rajjus, we get

One rajju $= 1{\cdot}63 \times 10$ 1 miles,

a quantity of the same order of magnitude as before.

Taking the definition of rajju given on p 105 *f.n.* *i.e.* rajju is the distance travelled by a Deva in six months at the rate of 2057152 yojans per instant of time we get, since one big yojan* = 4,000 miles,

2057152 yojans = 8228608000 miles

and 6 months $= 6 \times 30 \times 24 \times 60 \times 540000$ prativipalánsh†

$\therefore$ distance travelled in six months

$= 8228608000 \times 6 \times 30 \times 24 \times 60 \times 540000$ miles

$= 1\ 15 \times 10^{21}$ miles nearly.

*There is one element of uncertainty in the definition of yojan. the big yojan (used for measuring the dimensions of continents and seas) = 2000 koshás but whether one kosha = 2 modern miles of 1760 yards each cannot be said with certainty.

† 60 Prativiplánsh = 1 Prativipal (प्रतिविपल).
60 Prativipal = 1 vipal (विपल).
60 Vipal = 1 Pala (पल).
60 Pala = 1 Ghari = 24 minutes (घडी).

$\therefore$ 1 minute $= \frac{60 \times 60 \times 60 \times 60}{24} = 540000$ Prativiplánsh.

This is almost the same as the magnitude of rajju arrived at from the Einstein's value of the radius of the universe. If we identify the unit of time with Prativiplánsh, the agreement is quite close. The following points should, however, be noted in this connection :

(1) The dimensions of the universe have been estimated by Einstein on the basis of a spherical finite universe whereas the shape of the finite universe according to Jains is anthropomorphous with infinite pure space on all sides

(2) In the definition of rajju we have identified the instant of time (क्षण) with Prativiplánsh whereas a क्षण is said to be an infinitesimal fraction of time

Considering these odds, it is very difficult to make an exact comparison between the modern determination of the size of the universe and the determination of the ancients However all that has been said above reflects credit on the work of ancient thinkers.

Modern theories of the universe regard the universe as expanding although the final word has not yet been pronounced on this point.*

For further discussion on Space read pages 45–57 *ante*

*In "The Observational Approach to Cosmology" by Edwin Hubble, an authority on the subject, the author says: "The investigations lead to alternative pictures depending upon the alternative possible interpretations of red shifts" The author further goes on to say whether the 'red shift' in the spectra of the nebulae are due to the expansion of the universe or due to 'some unknown principle of nature' it is not yet decided.

According to Jain thought expansion of the universe is not possible, as there is no medium of motion outside the Loka. Sir Sulaiman's new theory supports our view-point.

Sutra 13.

"धर्माधर्मयोः कृत्स्ने" ॥१३॥

Dharmádharmayoh kritsne

=(धर्माधर्मयोः कृत्स्ने लोकाकाशे अवगाहः भवति)

(The whole universe or Loka is the place of Dharma and Adharma Dravyás)

Also · "धम्मा धम्मे य दो चेव, लोगमित्ता वियाहिया।"

—उत्तराध्ययन सूत्र अ० ३६ गाथा ७ ॥

(*Tr.*—Both Dharma and Adharma are co-extensive with Loka or universe.)

In order to make the point clearer, Achárya Amritchandra gives the following in *Tattvarth Sar*:

"लोकाकाशे समस्तेऽपि धर्माधर्मास्ति काययोः।
तिलेषु तैलवत् प्राहुरवगाहं महर्षयः ॥३३॥ अ० ३

Dharma and Adharma are placed in the universe (not like a pot inside a room) but permeate the whole of it as does oil inside the oilseeds.

Also in *Sarvarth Siddhi* :

"अगारेऽवस्थितो घट इति यथा, तथा धर्माधर्मयोर्लोकाकाशेऽवगाहो न भवति, किं तर्हि? । कृत्स्ने, तिलेषु तैलवदिति ॥ अन्योन्य प्रदेश प्रवेश व्याघाताभावोऽवगाहन योगाद्व दितव्यः ॥"

(*Tr.*—The Dravyás Dharma and Adharma are not situated in the universe like a pot inside a cabin. Then how? They pervade every iota of it as does oil inside the sesamum seeds. These Dravyás mutually interpenetrate without affecting their respective functions. This is possible because they possess the property of accommodation.)

The diffusion or interpenetrability of Dharma Dravya into Adharma and *vice versa* is difficult to explain by comparing it with a similar concrete case in Nature for these Dravyas are formless, non-material* and non-atomistic, whereas everything concrete in Nature is extremely porous. A similar difficulty is experienced in imagining how an infinite number of souls, who have attained Nirvána, are residing at Siddh Sila, which is of finite dimensions. This also is explained by saying that pure souls, being non-material, possess the power of interpenetrability and hence their existence, infinite at one place, is possible. The analogy of light is sometimes employed to explain these cases. The light from a single lamp can fill a whole room as well as light from a thousand different lamps; yet light given by each lamp does not lose its identity but only interpenetrates. However the point cannot be hidden that light is atomic If we assume these media to have parts, the necessity of assuming the existence of another medium filling the interstices will arise and the original difficulty will now be associated with this new medium and so on. Hence the only reasonable solution is to regard Dharma and Adharma as wholly continuous non-material media mutually interpenetrating like the electrostatic, magnetostatic and gravitational fields, which, although they are of different character do not mix; each preserves its individuality regardless of the other. (See p. 141, *The Evolution of Physics* by Einstein and Infeld.) Many instances may be quoted even in the case of material substances where

*"अमूर्तित्वाम्त्रयाणां परस्पर प्रवेशा विरोधः ॥" तत्वार्थ राजवार्तिक ॥ ५-१३-२ ॥

imagination has to put up with apparently glaring contradictions. Imagination is not always the test of possibility.

For instance, the law of gravitation for material bodies as quoted on p. 37 is that every piece of matter attracts any other piece but this law does not hold when the distance between the particles becomes very very small. The attraction changes into a repulsion. We quote from a standard book recently published: "Since two different atoms cannot be absolutely superposed on one another, it would seem that a repulsive force must come into play between two atoms when the distance is of the order 10^{-7} cm., and that Newton's law then ceases to hold."

—*Properties of Matter* by Champion and Davy (1936).

Is this not an apparent contradiction difficult for the mind to grasp ? Why should the force of attraction between particles change into a force of repulsion at small distances ? Even in ordinary life we see that the repulsive force which keeps the wife away from the husband changes into an attractive force and the wife does not want to be separated from her husband beyond a certain distance.

A similar point has been discussed on page 17 *ante* wherein the leading physicist Dr. M. N. Saha, F. R. S., says, "It is not at all clear how stripped atoms with a large excess of positive electricity can be so closely packed; because as the charges are of the same sign, the tendency would be for infinite dispersion instead of abnormal

condensation. But such cases of abnormal condensation are not altogether unknown in Physics."

Hale in 1918 demonstrated beyond doubt that the sunspots had an intense magnetic field of about 50,000 gauss, which is further confirmed by the phenomenon of Zeeman effect But this is quite unbelievable in the light of the experiments carried on the surface of the earth. The temperature of the sun-spots is very very high and experiments show that a white hot body cannot retain magnetism. In spite of this it exists in the body of the sun.

The antithesis between a wave and a particle is the burning problem of the day. Certain phenomena in physics are explained by saying that light energy consists of waves in æther and in certain others we have to postulate that light consists of a shower of bullets shot from the luminous body. How can these two contradictory aspects be reconciled? As Sir William Bragg has said "On Mondays, Wednesdays and Fridays we adopt the one hypothesis, on Tuesdays, Thursdays and Saturdays the other." This is a good piece of humour rather than an explanation. The contradiction becomes all the more conspicuous when we say that experiments have been discovered in which both ideas are found necessary *at the same time*, for instance in the case of counting the interference fringes by means of an electron-counter.

It is difficult to reconcile such cases of Pudgala Dravya what to say of the formless realities whose laws of interaction cannot be studied by experiments.

The young English physicist Dirac introduced at one time the apparently funny conception of the electron of "negative mass"—the electron which 'does not in any way betray its existence by any measurements whatsoever,—which has played its role on the stage of the universe and retired for good.'

These examples suffice to show that however hard it may be for the imagination to deal with the interpenetrability of Dharma and Adharma Dravyás, it is nevertheless the legitimate explanation of things.

Now coming to the next point, *viz.*, the existence of these substances (media) within the confines of the Loke and not beyond, we find that this is a much more reasonable and satisfactory assumption than Einstein's finite universe "with no space beyond a certain space". According to the Cylinder theory of the universe, (*vide p* 55 *ante*) we cannot think of a beginning of the universe nor will it ever come to an end In other words, it is a stable unit. If we regard our universe as infinite it cannot be stable at the same time, for in that case we can think the infinite space to be filled with a number of universes and their attractions on our universe would scatter it into infinite space. In order, therefore, to maintain the stability of our universe running from an infinite past into an infinite future the universe was conceived as of finite dimensions, but since mathematical conditions negative the idea of a void beyond finite universe, the whole space was taken to constitute the finite universe.

The Jain concept is more comprehensive because the stability of the universe is maintained by saying that there are no media of motion and rest beyond a certain limit and consequently matter or energy *could never go out of it, i. e.,* the total energy of the universe will ever remain constant. Further, since Jainism regards space as a reality, there is no void beyond Loka but only one substance,--pure space and nothing else. All the difficulties are thus ingeniously overcome.

Sutra 14.

"एक प्रदेशादिषु भाज्यः पुद्गलानाम् ॥१४॥"

(Eka pradeshádishu bhájyah pudgalánám.)

=लोकाकाशे एक प्रदेशादिषु भाज्यः एक प्रदेशसंख्येयासंख्येयानन्त-अनन्तानन्त प्रदेशानां पुद्गलाना अवगाहः ।

(*Tr.*—In one pradesha, *i. e.*, in one unitary cell of space only one atom of matter will find place if it is in a free state but in an aggregate form any number of atoms can occupy one or more cells of space.)

The same idea is expressed in *Dravya Samgrah* :

"एक प्रदेशः अपि अणुः नाना स्कन्ध प्रदेशतः भवति" ॥२६॥

(An atom of matter, though occupying one cell of space, may occupy many cells when it combines with other atoms to form different Skandhás (aggregates). From this point of view it may be looked upon as multicellular (बहु प्रदेशी).

The author of *Sarvarth Siddhi* has explained this phenomenon, in greater detail, thus:

"एकस्मिन्नाकाश प्रदेशे परमाणोरवगाह: द्वयोरेकत्रोभयत्र च बद्धयोरबद्धयोश्च त्रयाणामेकत्र द्वयोस्त्रिषु च बद्धानामबद्धानां च ॥ एवं संख्येयासंख्येयानन्त प्रदेशानां स्कन्धानामेक संख्येयासंख्येय प्रदेशेषु लोकाकाशेऽवस्थानं प्रत्येतव्यम् ॥ ननुयुक्तं तावद मूर्त्तयोर्धर्माधर्मयोरेकत्रा विरोधनावरोध इति। मूर्तिमतां पुद्गलानां कथमित्यत्रोच्यते—अवगाहन स्वाभावत्वात्सूक्ष्म परिणामाच्च मूर्तिमतामप्यवगाहो न विरुद्धयते। एकापवरके अनेक दीप प्रकाशावस्थानवत् ॥

(One atom occupies one cell of space or two atoms in a state of abnormal condensation may be accommodated in the same cell. Two free atoms will occupy two cells as well as two atoms forming a diatomic molecule will cover two cells. Three atoms can be located in a single cell if they are all in a state of abnormal condensation;* they can occupy two cells if two atoms are in a state of condensation and one is free; they occupy three cells if they are all free. And this process is to be continued to infinity.)

Then the question has been raised as to how such an enormous crowding of material atoms is possible, although interpenetrability may be true in the case of non-material media like Dharma and Adharma. The answer given is that these are cases of abnormal condensation like the superposition of lights from different lamps in a single room.

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* For an explanation of "abnormal condensation," *i. e.*, **सूक्ष्म अवगाहन शक्ति** read pages 4-18 *ante*.

The same reason has been assigned for this crowding by other writers. For instance:

"अधिकरण विरोधादानन्त्याभाव इति चेन्न सूक्ष्म परिणामावगाहन सामर्थ्यात् ॥"

—तत्वार्थ राजवार्तिकम् ।५।१।३।

Or "अवगाहन सामर्थ्यात् सूक्ष्मत्व परिणामिनः ।
निष्ठेन्त्येक प्रदेशेऽपि बहवोऽपि हि पुद्गलाः ॥"

—तत्वार्थसार ॥३,२६॥

This distribution of atoms in pradeshás or cells of space has a very great likening to the distribution of particles in Bose-Einstein or Fermi-Dirac Statistics where probabilities of various combinations have been mathematically calculated. We can only make a passing mention of this highly complex piece of mathematics.

In the standard work "A Treatise on Heat" by Dr M N. Saha, F. R S., and B. N Srivastava, the calculation of probability from Bose-Eintein Statistics is given on p 717 'The next operation is to distribute these N-particles amongst A, cells so that each cell may contain 0, 1, 2, . .up to N, identical particles." Then follows the expression for the probability of the various states.

Also on page 718 "In the Bose-Einstein Statistics a particular cell or degree of freedom was supposed to be capable of accommodating any number of particles. Fermi conceives a third kind of statistics in which one cell should not accommodate more than one particle."

How an infinite number of atoms in a subtle (सूक्ष्म) state can be accommodated in one cell has been discussed in pages 16–17 *ante*.

Sutra 15.

"असंख्येय भागादिषु जीवानाम्" ॥१५॥

Asankhyeya bhágádishu jivánám.

=(लोकाकाशे असंख्येय भागादिषु जीवानाम् अवगाहः भवति) ॥

(Souls are existent in every iota of space beginning with one or more countless fractions of it up to the whole universe, *i. e*, if the space is divided into countless parts, the size of a soul can be so small as to occupy one or more of these parts and in special cases the size of a single soul can fill the whole universe)

"अणु गुरु देह प्रमाण. उपसंहार प्रसर्पाभ्यां चिदात्मा" ॥१०॥

—द्रव्यसंग्रह ॥

(Jiva becomes equal in extent to a small or a large body by contraction and expansion.)

This view of the Jains has been badly criticized by Shankarácharya in his commentary on Vedánta-Sutra (अ० २, पाद २, सूत्र ३४). He argues that if a soul is equal in extent to its body, it is impossible that the same soul can enter into the bodies of a fly and an elephant. In fact there is a controversy amongst the philosophers regarding the precise part of the body which should be assigned as the seat of the soul. Some think it is located in the heart, others think it is located in the head or in some specific brain centres. If this view is accepted it is difficult to think how

one could feel the bodily affections as its own. Since a body grows from a microscopical size in the mother's womb to its full proportions and contracts again, at the end of its earthly career, to reincarnate into a new seed, it follows that the size of the soul cannot remain fixed.

This subject is well discussed by S. J. Maher in his work on Psychology where he says : "(the soul is) an immaterial energy exerting its proper activities ubiquitously throughout the living body."

According to the Jain view the soul expands to fill the whole universe at the time of Samudgháta* (*i. e.*, exit of the soul from the body without leaving the original body altogether).

Science associates life† with tiny organisms called

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*"मूल सरीरम छंडिय उत्तर देहस्स जीव पिडस्स ।
णिग्गमणं वेहादो हवदि समुद्घादयंणाम् ॥६६७॥"

—गोमट्टसार जीवकांड ।

†"Protoplasm, the fundamental constituent of both plants and animals, contains chemical compounds........chief amongst these are the proteids. It is the presence of these unstable proteids which confers upon protoplasm its peculiar fitness to form which has been so aptly termed by Huxley 'as the physical basis of life'"

—*Arthur Dendy, p.* 7.

" Whatever view we may take with regard to the question of vitalism, there can be no doubt that the most distinctive property of living protoplasm is its power of controlling chemical and physical processes so as to make them yield results different from those which would be obtained if we were dealing with not-living matter. The various processes upon which depend the functions of movement, nutrition, respiration and excretion all appear to be controlled in this manner...."

Ibid., p. 23

cells which are composed of a substance named 'protoplasm'. According to Arthur Dendy, D. Sc., protoplasm " is a mixture of proteids, mineral salts and water, which has remarkable powers of selection, *e. g.*, one organism will select silica while another selects calcium carbonate from the same sample of sea-water and for the same purpose".

—*Outlines of Evolutionary Biology.*

It is evident that 'life' must be associated with protoplasm since non-living combination of matter cannot be thought of as possessing the power of selection referred to above

"Protoplasm is the name for the viscous fluid which contains the life of every cell."

—*Exploring the Universe* by H. Ward, p. 145.

"This tiny cell has powers and complexities that put it in the class of a higher animal. You cannot hope to account for its substance* until you are able to melt down a whole animal and account for its emotions by rows of O and H and C and some numerals.† The ultimate analysis of a cell must be as difficult as the analysis of a robin. When you give a common name, protoplasm, to the substance that you find in all cells you are not saying anything."

—*Ibid.*, *p.* 146.

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*The substance is the life, the soul.

—*The Author.*

†Refers to a chemical formula in terms of oxygen, hydrogen and carbon.

Dr. John Baker gives us the following information on page 187 of "An Outline for Boys and Girls and Their Parents" :

"Quite recently a most ingenious apparatus has been invented, by means of which we can poke an extremely fine glass needle into a single living cell and watch what happens under the microscope.... This is an extraordinary achievement. Another most striking line of research is to take a few cells out of a living body and keep them alive in a little glass compartment......It is astonishing how long they live if you are very careful to seal them into their glass compartment without letting any germs get in. These studies of living cells are going to form a very important branch of the science of life."

Since all living bodies are composed of cells, beginning from that amœba (a unicellular organism), which propagates its progeny by fission of its body, to highly complex organisms like that of a man whose body is composed of trillions of such cells, it follows that life and hence soul must permeate every living cell, *i. e.*, soul is co-extensive with the body. The experiments of Sir J. C. Bose, F. R. S., on the response of plants* under chemical or electrical stimulus point in the same direction, *i. e.*, diffusion of the soul in the entire body of the plant.

*The faculty of receiving and responding to stimuli of various kinds is one of the most characteristic features of living protoplasm.

—*Arthur Dendy, p.* 215.

Sutra 16.

"प्रदेश संहार निसर्पाभ्यां प्रदीपवत" ॥ १६ ॥

(Pradesha samhára visarpábhyám pradipavat.)

= (प्रदेश संहार विसर्पाभ्यां प्रदीपवत लोकाकाशे असंख्येय भागादिषु जीवानाम अवगाहः भवति).

(*Tr.*—By the contraction and expansion of the pradeshás, the soul, although it has a countless number of pradeshás, occupies space like the light from a lamp. It can occupy the smallest possible body, *viz.*, that of a bacterium or the biggest body of a Mahámachchha (महामच्छ), with a length of 1,000 yojans)

According to Jains, therefore, a soul, although devoid of parts, is capable of expansion and contraction, like the light from a lamp and can become co-extensive with the universe under special circumstances. Seven kinds of Samudgháta are recognized in Jain philosophy:

वेदना समुद्घात (Vedaná Samudgháta)—Extension of the soul outside the body through excessive pain in search of the proper herb which would heal up the pain. When the pradeshás of the soul come in contact with the required herb, the pain disappears and then the pradeshás contract and the soul occupies the normal position inside the body.

कषाय समुद्घात (Kasháya Samudgháta)—Extension of the soul outside the body through excessive anger in order to cause injury to the source of provocation.

विक्रिया समुद्घात (Vikriyá Samudgháta)—The potentiality of the soul by virtue of which it can extend or diminish the size of the body enormously or can form a number of living bodies by extension of the pradeshás. For instance it is said in Hindu *Ramayan* that Hanumán, going in search of Sitá, visited Ashok Vátiká, in the diminutive form of a fly or it is reported that the great/Yogi Lord Shri Krishna used to dance with Gopis, each Gopi with one Krishna to pair.

मरणांतिक समुद्घात (Marnántik Samudgháta)—The extension of the soul, just before death, to the place where it is going to be re-born and the subsequent restitution after the visit.

तैजस समुद्घात (Taijas Samudgháta)—is of two sorts, Shubha, and Ashubha. In the first kind, we have the exit of a white form, twelve yojans in length, nine yojans broad from the right shoulder of a sage through extreme commiseration when famine or epidemic spreads in some part of the country. After destroying the calamity the figure re-enters the body. In the latter kind, a red figure of similar dimensions issues forth from the left shoulder during excessive rage, and after wreaking vengeance destroys the sage himself.

अहारक समुद्घात (Ahárak Samudgháta)—The exit of a white human figure, one cubit in length, from the forehead of a sage to resolve a doubt by seeing some Kevali (a saint possessed of infinite knowledge).

केवली समुद्घात* (Kevali Samudgháta)—Under some special circumstance the soul of an Arhant (Pure-Soul Incarnate) expands and fills up the whole universe without leaving the original body.

All systems of Indian philosophy regard soul as potentially divine and the seven forms of Samudgháta described above give an idea of the latent capacities of the soul, but one thing which human mind fails to grasp is "how can a substance without parts expand and contract like this ?"

The great mathematician Professor Max Born, in his work "The Restless Universe" has told a fairy tale on page 240 in which a gnome presents a boy with a money-box in the form of an earthenware-ball hermetically closed on all sides. The boy moves about, shaking the ball all the time and at random moments a gold piece jumps out of the solid ball, although there is not even a trace of hole in it.

Prof. Born adds the following in conclusion: "For what we have just described as happening in a fairy tale, *pieces of solid matter moving through solid walls does actually happen* when nucleii emit alpha-particles." It is worthy of notice that even in this highly rationalistic age of Science such apparent absurdities find a passport. The reason is that the facts cannot be overlooked, whether we are able or not able to offer 'a rational explanation' for them. For instance, in the issue of "Armchair

*For details of various kinds of Samudgháta read *Gommat Sar, Jivakanda* ghás 543-667-669, S. B. J , Vol. V.

Science" (London) for December 1937 we read of "men who see without eyes." After describing the case of Ouvrieu, the writer says, "There is not the least doubt of the facts of this case, as they are supported by the testimony of noted specialists.." and adds that "these phenomenal powers are indeed seldom capable of rational explanation." Next he quotes the case of the famous clairvoyant Kele, who has during the last seven years detected several cases of would-be suicides and pre-meditated murders "He possesses an inexplicable faculty for knowledge and psychiatrists, while compelled on the evidence to accept the facts, are totally at a loss to offer any convincing explanation." Many such instances can be multiplied However in the present case there is one ocular evidence

The protoplasm, with which biologists associate the phenomena of life, possesses a remarkable property of *contraction* under stimulus electrical or otherwise. It can be easily seen with the eyes as demonstrated in the famous experiments of Sir J. C. Bose, F R. S Contraction of protoplasm means contraction of living substance, the soul, showing thereby that the hypothesis of the expansion and contraction of the soul substance is tenable

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Sutra 17.

"गतिस्थित्युपग्रहौ धर्माधर्मयोरुपकार:" ॥१७॥

(Gatısthityupagrahau dharmádharmyorupkárah.)

=जीवानाम् पुद्गलानाम् च गतिस्थित्युपग्रहौ धर्माधर्मयोरुपकारः भवति ॥

(*Tr* —The function of Dharma and Adharma is to support respectively the motion and rest of souls and matter.)

These Dravyás and their nature have been fully discussed in pages 18 to 45 *ante*. We shall deal here with a few points more:

The author of *Sarvarth Siddhi* has raised various interesting questions and then answered them satisfactorily. What is the harm if we associate the functions of motion and rest with the space which exists everywhere? The answer is "**एकस्यानेक प्रयोजन कल्पनायां लोकालोक विभागाभाव:**" "By doing so, the division between Loka and Aloka, finite universe and infinite empty space surrounding it, would disappear." As has been discussed on pages 123 *et seq.* this division is absolutely essential in order to ensure the stability and eternity of the universe.

The next question raised and answered by him is "**तुल्यबलत्वरवात्तयोर्गतिस्थिति प्रतिबन्ध इति चेन्न—अप्रेरेकत्वात्**" "How can motion or rest be possible when the Dravyás Dharma and Adharma are uniformly distributed in the universe and have equal potency ? *i. e.*, the motion of bodies would be opposed by the co-existing and co-operative forces of Adharma and *vice versa*." And the answer given is: It is not so because Dharma and Adharma are not active forces but passive media. The same idea in *Rajvartik* is expressed as follows

"अभयानुग्रहात्परस्पर प्रतिबन्ध इति चेन्न स्वतः परिणाम सामर्थ्य स्यानुग्रहाकांक्षित्वात् कुंट नयनयष्टि प्रदीपवत्' ॥ तत्त्वार्थ राज-वार्तिक ॥५।१७।२४।

Just as a lame possesses the power of walking or an eye possesses the power of seeing, but the former requires the aid of a crutch or the latter needs light in order to see, so does the motion and rest of bodies need the help of the invisible media, Dharma and Adharma.

We have shown in the commentary on Sutra 1 that the Aether of the scientists is the inactive medium, corresponding to Dharma Dravya, which helps in the motion of things, while Adharma is another invisible medium, called the Field, through which the forces of gravitation and electro-magnetism operate and maintain the stability of the microscopic as well as of the macroscopic world. The phenomenon of gravitation, as explained by Einstein is a passive property, wrongly associated with Space. (See page 42 *ante*.) We give below a few more quotations to show that the scientists do recognize a separate medium for the 'rest' of the bodies.

"The gravitational constant is independent of the nature of masses. The same researches proved that the gravitational constant is independent of the state of chemical combination of the elements in the masses. The fact that an element is radioactive has also been shown to have no effect on the gravitational constant. Eotvois and his collaborators and also Majorana, Austin and Thwing have investigated the effect of interposing layers of different media between attracting and attracted bodies. Very dense media, such as lead and mercury, were used. No effect could be detected."

—*Properties of Matter* by Champion and Davy, p. 43.

The gravitational constant represents the action of the medium on the phenomenon of gravitation and since the medium is non-material, invisible, and passive we see that its properties do not change whether we bring mercury or lead between attracting bodies or bring out any physical or chemical change in the surrounding things.

"Gravitation is linked up with light and *other electro-magnetic phenomena.*"*

—*Ibid, p.* 45.

This statement amounts to saying that the cause of 'rest' of the electrons inside an atom, or that of atoms inside a molecule is the same as that which keeps the members of the solar system together. More recently N R Sen has shown that Einstein's modified field equations have the consequence than an electron of finite radius must have $\frac{3}{4}$ of its total energy of electro-magnetic origin and $\frac{1}{4}$ of gravitational origin (*Zet f. Physik*, 40). This leaves no doubt that the reality, which Jain philosophers have given the name Adharma, is responsible for the stability of the atoms and the molecules as also of the galaxies and the solar system. This Adharma Dravya is being called under the name of "field of gravitation" or the "electro-magnetic field" which for want of clear

*Gravitation is said to be the cause of stability of the macroscopic world, the galaxies or the solar system while electro-magnetic forces account for the binding of atoms within a molecule According to the Jains both these functions are discharged by the same Dravya, Adharma. This view is confirmed here. See also pages 97 *et seq.*

conception is vaguely associated with the surrounding space. So that we read:

"All matter or energy modifies the properties of Space-Time in its neighbourhood, producing what is called a field of gravitation....It is not a direct instantaneous action at a distance produced by an attracting body. The cause of the deformation of space-time in the neighbourhood of matter or energy, that is, the cause of gravitation, is still unknown."

—*Ibid, p.* 45.

Since 'science' means 'measurement' and Invisibles are not always susceptible to measurement, the scientists cannot posit any invisible entity unless the postulate is extremely essential for explaining phenomena in Nature. Many such invisible quantities do exist with the scientists, whose nature they are ever trying to explore. For instance, they have lately postulated the existence of an unknown particle 'neutrino' to save *the law of conservation of matter and energy** from breaking down. So we read in the "Reports on the Progress of Physics," Vol. III (1937, London), p. 95: "Attempts to detect any ionization by the neutrino have failed, and the *only evidence for its reality is in its success in accounting for the facts of beta-ray disintegration.*"

Shri Pujyapáda himself has raised the question .

"अनुपलब्धेर्न तौ स्तः खर विषाण वदिति चेन्न—" "सर्वज्ञेन निरतिशय प्रत्यक्ष ज्ञान चक्षुषा धर्मादयः सर्वे उपलभ्यन्ते।"

*"The law is: Matter or energy can change form but they are indestructible".

Are not the Dharma and Adharma Dravyàs like the horns of a donkey, when they are not visible with the eyes ? He answers, No. The Omniscient eyes of the 'Universal Observer' have seen these Dravyás which is the ancient way of saying that these realities are absolutely necessary in order to explain the processes in the universe.

We are, therefore, of opinion that if instead of vaguely talking about 'fields of electro-magnetism and gravitation'* we postulate in clear terms a separate medium of rest, like the æther, many difficulties would disappear.

Science is at present fumbling over the question of Adharma Dravyà. As we have mentioned on p. 43 *f n.* the nearest approach to this concept is the Field of the physicists. But they are again trying to associate material properties with this immaterial medium, the exact nature of it being still a matter of controversy. We quote here a few lines from *The Evolution of Physics* by Einstein and Infeld, p. 256:

"We have two realities , *Matter and field.* There is no doubt that we cannot at present imagine the whole of physics built upon the concept of matter... But what are the physical criterions distinguishing matter and field ?...We could say, Matter is where the concentration of energy is great, field where the

*In the report published in the "Hindustan Times" of 31st August 1938, of a paper read by Sir Sulaiman before the National Academy of Sciences, India, at Allahabad, on 28th August it is said that 'Sir Shah Sulaiman has developed his theory further, claiming to have identified gravitation with electricity.' If so, the Jain view of Adharma Dravyà finds full confirmation.

concentration of energy is small. But if this is the case, then the difference between matter and field is a quantitative rather than a qualitative one. There is then no sense in regarding matter and field as two qualities quite different from each other. It seems impossible to give an obvious qualitative criterion for distinguishing between matter and field. .. Could we not reject the concept of matter and build a pure field physics ?....We have not so far succeeded in fulfilling this programme convincingly and consistently. At present we must still assume in all our theoretical constructions two realities: field and matter.

Sutra 18.

"आकाशस्यावगाह" ॥ १८ ॥

Akáshasyàvagáh.

=जीवानाम्-अजीवानाम् च आकाशस्य उपकारः अवगाहः ।

(The function of Space, *i. c*, Akásha is to give place to all other substances.)

The nature of Akásha has been an intriguing problem for long. The Idealistic school of philosophy in the East as well as in the West has regarded it merely as a 'form of conception'. Kant, the great European philosopher of this school, regarded the external objective world including 'the starry heavens above' as a fictitious creation of the human mind. Nature or Prakriti, according to him, arises out of the co-operation of sense-materials and the activity of mind, Space and time form the *a priori* constitutive elements of experience.

The metaphysical dualism of Kant was converted into idealistic monism by the German philosopher Hegel. He reduced all finite things and persons as mere attributes of a certain Absolute of the nature of a spirit. Herbert Spencer, in his own way, strengthened the arguments in favour of monism and phenomenality of experience. The European scholars like Max Muller and Deussen were influenced by the same ideas. In the East the Vedánta school advocates the uncompromising theme of monism (Advaitváda) and has no explanation to offer for time, space and the Laws of Causality which constitute the world of matter and energy.

The times have changed now. The Hegelian doctrine, as sponsored today by Bradley and Bosanquet, which identifies thought with Reality, is openly 'condemned as pernicious metaphysics.' This is due to the introduction of modern scientific methods in the pursuit of knowledge. The Idealistic school regarded Nature as a form of conception, the new school of Realism regards 'concept as a convenient fiction to comprehend Nature.'

"The mathematical discoveries of Cantor, Peano and Frege have once for all reclaimed certain fundamental mathematical notions such as the concepts of infinity and continuity from the unwarranted criticisms of metaphysicians. As Mr. B Russell clearly points out, modern Idealism must once for all relinquish its Kantian basis. It can no more depend upon the so-called demonstration offered by Kant as to the impossibility of real space and time.

The wave of Realism is further intensified by the fact that it is intimately associated with modern science. The traditional Hegelian idealism of the West has been peculiarly adverse to the interest of science. It may be safely asserted that a system of metaphysics which does not take into consideration the method and achievement of modern science is so far self-condemned......The Jain system of thought is peculiarly consistent with modern Realism and modern Science......"

—*Historical Introduction, S. B J. Series, Vol. III. p. xix,* A Chakravartty.

The reprsentative school of Hindu Realism, *viz.*, the Vaisheshik philosophy, no doubt, regards Akásha as one of the nine realities constituting the universe but the properties associated with it are more those of Aether rather than that of mathematical space (see p. 90 *ante*).

"The reality of space is also borne out by the fact that in order to reach things it is necessary to traverse the distance which separates them from ourselves. Further the removal of space can only result either in the throwing of all things into '*nowhere*,' or in the complete isolation of each individual atom from all the rest of its kind, and into being doomed to an eternal solitary confinement. The one is, however, as inconceivable as the other, for 'nowhere' is as great an absurdity as absolute vacuity and isolation is only possible in space, never in spacelessness."

—*Key of Knowledge*, p. 747-48.

The great astronomer Prof. A. S. Eddington is right when he says: "We must rid our minds of the idea that the word space in science has anything to do with *void.* As previously explained it has the other meaning of distance, volume, etc., quantities expressing physical measurement.... In any case the physicist does not conceive of space as void. Where it is empty of all else there is still the aether."

The slight misconception expressed in the last sentence, *viz*, where it is empty of all else there is still the aether, has arisen out of the fact that although scientists have come to regard space as a reality and associate all necessary qualities with it and more but they have failed to regard it as a substance in itself. If the latter point is accepted it is quite easy to see the truth of the Jain view that beyond finite universe there is infinite extension of the space substance. If space were finite, 'it would be limited by something else and would have a *beyond* to it which must be either another piece of space or pure emptiness.' Since the latter is an impossibility, it must be the former and therefore space must be a real substance, *'for pure expansion is not thinkable in the absence of a substance in which it might inhere.'*

Consequently the claim of space to rank amongst one of the fundamental substances constituting the universe is firmly established.

Sutra 19.

"शरीर वाङ्मनः प्राणापानाः पुद्गलानाम्" ॥१९॥

(Sharira vánmanah pránápánáh pudgalánám.)

=शरीर-वाङ्-मनस्-प्राण- अपानाः जीवानाम् पुद्गलानाम् उपकारः ।

(Matter forms the physical basis of the bodies, speech, mind and respiration of the souls.)

In *Gommat Sar*, the brilliant composition of Shri Nemichandra Siddhánta Chakravarti, we read the following :

पुद्गलाः पुनः,
देहादि निर्वर्तन कारण भूता हि नियमेन ॥ जीवकांड, गाथा ६०६॥
आहार वर्गणात्: त्रीणि शरीराणि भवन्ति उच्छ्वासः ।
निश्वासोपि च तेजो वर्गणा स्कंधात्तेजोंगम् ॥६०७॥
भाषा मनोवर्गणातः क्रमेण भाषा मनश्च कार्मणतः ।
अष्टविधि कर्मद्रव्यं भवतीति जिनैर्निर्दिष्टम् ॥६०८॥

(*Tr.*—Matter is the cause of making of the bodies. One kind of molecules, called Ahárak varganá, form the first three types of bodies described on pages 81-82 and the respiration. Electrical energy (Tejo-varganá*) forms the fourth type, *viz.*, the electrical body.)

Speech and mind (मन) are constituted by another two specialized forms of matter-molecules called respectively Bháshá-varganá and Mano-varganá. The inner subtle body (कार्मण शरीर) which is the seed of all mental and physical activities is made of eight kinds of kármic matter.

The fifth class (सूक्ष्म) out of the six sub-classes of matter (*vide* p. 83 *ante*) has been further divided into five divisions called varganás: आहार वर्गणा, तैजस वर्गणा, भाषा वर्गणा, मनो वर्गणा and कार्मण वर्गणा. This is a case of specialization of fine 'matter.' A similar specialization

*It should be noted here that Jainism regards electrical energy as atomic and so it is

has been found to exist in the case of protoplasmic cells of living matter. For instance, the great biologist, Arthur Dendy writes as follows:

"There is another point of view with regard to the living cell....It is not only the morphological or structural unit of the body but also the physiological or functional unit."...... p. 68.

Human body has been estimated to contain 26 trillion cells but divided into groups, each group has a special function to perform. The group of cells, which constitutes the eye, cannot discharge the function of the auricular group and this differentiation cannot be explained unless we assume that matter constituting the various groups of cells is differentiated in some way.

Matter supports the process of respiration is clear from the following:

"Respiration, in the scientific acceptance of the term, is simply the exchange by the organism of the carbon-di-oxide gas which has been formed in the body in the process of combustion for the oxygen gas which is required for that combustion. It is therefore a double function—oxygen being taken in and carbon-di-oxide got rid of by one and the same process"

—*Ibid*, p. 8.

Sutra 20.

"सुख दुःख जीवित मरणोपग्रहाश्च" ॥२०॥

(Sukha dukha jivita marnopagraháshcha.)

=जीवानाम् सुख-दुःख-जीवित-मरण-उपग्रहाःच पुद्गलानां उपकारः भवति ।

(Soul experiences pain, pleasure, life and death through the agency of matter.)

Shri Kundkundácharya says in *Niyam Sar*—

"कर्ता भोक्ता आत्मा पुद्गल कर्मणो भवति व्यवहारात् ।" ॥१८॥

(From the practical point of view, a worldly soul draws in fine kármic matter in consequence of the activities of mind, body and speech and experiences their results.)

The theory of the transmigration of soul has been explained by Jains in terms of kármic matter, —an extraordinary conception found in no other system of thought. According to this view, all actions of embodied living-beings, whether mental or physical, including speech, are followed by an influx of fine molecules of energy towards the soul, the latter constituting what is called the Kármán Sharir (*vide* p. 82 *ante*). Activity of a good kind attracts meritorious while activity of a bad kind attracts the opposite kind of kármic matter. The Kármán Sharir is the vehicle of transmigration and passes from life to life. The dragging of the soul from one physical body to another is well described by late Mr. J. L. Jaini on p 29 of the *Outlines of Jainism*.

"It is not fate, nor even predestination · but it is the ever-continuous balancing of the different accounts that we keep with the forces of life. There can be no mistake, no suppression and no evasion. The credit and debit sides go on automatically; and whatever is due to us is paid us ungrudgingly and without demand. The continuity cannot be broken by change of house; the debts of London are not

extinguished by going to Berlin : nor is the liquidation suspended till the Day of Judgment. The karmás are not extinguished simply because we give up the body called A. When we are dead as A, the karmás must still bear full fruits. The karmás constitute the Kármic body and it drags us into another state of being."

The fusion of soul with matter results in the production of eight kinds of forces : those which obstruct knowledge, those which interfere with perception ; those which obstruct right beliefs; those that regulate the experiences of pleasure and pain; those which are responsible for the building of different kinds of bodies and shaping the limbs ; those that determine the duration of life; those that determine the lineage of the individual and lastly those which interfere with the doing of desired actions.*

The union of kármic matter with soul lasts for a limited time according to the intensity of passion present at the time of the influx. During this time it produces its effects and then sheds off gradually just as food and medicine produce effects inside the body for some time and then go out. Control of mind, body and speech leads to the prevention of Kármic matter coming in and total freedom from all Kármic matter raises the soul to the status of divinity.

The theory outlined in the previous paragraph seems to be confirmed by the picture of life in which the activities of mind and matter constitute a

*For a fuller and detailed account of these forces read *Gommat Sar, Karm-kanda,* S B. J Series, Vol. VI.

super-radio sending and receiving a continuous chain of electrical waves, an account of which is given on p. 91 *et seq.* Influx of these waves is nothing but the influx of fine Kármic matter.

Not only is matter the basis of pleasure, pain, life and death but one piece of matter is capable of producing physical and chemical changes in another piece of matter. This fact is connoted of the word '*Upgraha*' (उपग्रह) in the Sutra. Says the author of *Sarvartha Siddhi*:

"स्वोपग्रह प्रदर्शनार्थ मिदम्। पुद्गलानां पुद्गल कृत उपकार इति॥ तद्यथा—कंस्यादीनां भस्मादिभिर्जलादीनां कतकादिभिरयः प्रभृतीना-मुदकादिभिरुपकारः क्रियते।"

The examples given here are the purification of bronze by the addition of certain ashes, the purification of water by the addition of an organic substance *Nirmali* and tempering of steel with the help of water

No more examples need be multiplied in this connection as it is well-known that the whole superstructure of modern science is built upon physical and chemical changes in matter.

Sutra 21.

"परस्परोपग्रहो जीवानाम्" ॥२१॥

(Parasparopgraho jívánám.)

=परस्परोपग्रहो (जीवानाम्) जीवानम् (उपकारः) भवति ॥

(The mundane souls help and support each other.)

The author of *Sarvarth Siddhi* amplifies this Sutra as follows:

"स्वामी भृत्यः, आचार्यः शिष्यः, इत्येवमादि भावेत वृत्तिः परस्परोपग्रहः ॥ स्वामी तावद्वित्त त्यागादिना भृत्यानामुपकारे वर्तते। भत्याश्च हित प्रति पादनेनाहित प्रतिषेधेन च ॥ आचार्य उभय लोक फलप्रदोपदेश दर्शनेन तदुपदेश विहित क्रियानुष्ठापनेन च शिष्याणामनुग्रहे वर्तते। शिष्या अपि तदानुकूल्यवृत्या आचार्याणामुपकाराधिकारे ॥"

(The master and his servant, the teacher and the taught are examples of mutual obligation. The master helps the servant with money and the servant repays through his humble service; a teacher renders a great service through his sound training and advice while the pupil repays the same through his good conduct.)

The meaning of this Sutra is too obvious and needs no elaborate commentary. We all depend upon one another. The peasant provides corn to humanity, the weavers the clothes and so on. Not only that, we very often are the cause of pleasure and pain to others and sometimes responsible for their lives and deaths.

This Sutra has a great ethical value; it enjoins all wordly beings as a duty to live in co-operation and harmony, doing no harm to anybody so that eternal peace may reign on earth.

Sutra 22.

"वर्तना परिणाम क्रियाः परत्वा परत्वे च कालस्य" ॥२२॥

(Vartaná parinám kriyáh paratvá paratve cha kálasya.)

=वर्तना-परिणाम-क्रियाः-परत्वा परत्वे च जीवानाम् पुद्गलानाम् कालस्य उपकारः भवति ।

(The function of time is to assist substances in their continuing to exist (वर्तना), in their modifications (परिणाम), in their movements (क्रिया)* and in their priority (परत्व) and non-priority or juniority in time (अपरत्व).

In other standard Jain works the time has been defined as follows.

"वत्तना लक्खणो कालो० ।"

—उत्तराध्ययन अ० २८ गाथा १०

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*The Jain Acháryás have described 10 kinds of motions.

"प्रयोग बंधाभावच्छेदाभिघातावगाहन गरु लघु संचार सयोग स्वभाव निमित्त भेदात् ।। तत्वार्थ राजवार्तिक ।।५।२२।२६।।

प्रयोग गति—Motion of a projectile such as a bullet or a missile.

बंधाभाव गति—Uncoiling of a spring or sprouting of a seed

छेद गति—Motion of sound waves as compressions and rarefactions in air

अभिघात गति—Motion of particles during an explosion

अवगाहन गति—Motion in a resistive medium such as that of ships in a sea or of aeroplanes in the air.

गुरु गति—Free fall of a heavy body.

लघु गति—Motion of cotton flakes in air or Brownian movement.

संचार गति—Motion through diffusion.

संयोग गति—Motion on horseback.

स्वभाव गति—Natural motions of air, of the solar system and or the electrons inside an atom.

वर्तना (Assisting in their continuity of being) is the characteristic of time.

"जीवादि द्रव्याणां परिवर्तन कारणं भवेत्कालः" ॥३३॥

—नियमसार

(That which helps all substances, soul, etc., in undergoing modifications, is time.)

वर्तना हेतुः कालो वर्तना गुणमवेहि द्रव्य निचयेषु ।
कालाधारेणैव च वर्तन्ते हि सर्व द्रव्याणि" ॥५६८॥

—गोमट्टसार, जीवकांड

Time is the cause of continuity in being. The attribute of continued existence is in all the six realities of the universe. And all substances undergo change through the support of time.)

"न च परिणमति स्वय स न व परिणामयति अन्य दन्यैः ।
विविध परिणामिकानां भवति हि कालः स्वयं हेतुः" ॥५७०॥

—गोमट्टसार, जीवकांड.

(Time never alters itself into other substances nor does it change other substances into itself. It is merely the auxiliary cause of different kinds of modifications in other substances.)

"द्रव्य परिवर्तन रूपः यः स कालः भवेत व्यवहारः ।
परिणामादि लक्ष्यः वर्तना लक्षणा च परमार्थः" ॥२१॥

—द्रव्य संग्रह

Practical or Apparent Time is that which is known from modifications produced in substances, while Real Time is that which helps to produce changes in substances and is understood from continuity.

According to Jains time is divided into two classes व्यवहार काल and निश्चय काल, *i. e.*, Apparent and Real Time.

Apparent Time is defined as:

"नव जोर्णादि पर्यायैर्द्रव्यानां यः प्रवर्त्तकः ।
समयादि मयः कालो व्यवहाराभिदोऽस्ति सः ॥"

वर्द्धमान पुराण ॥१६,३४॥

Apparent Time consists of hours, minutes, seconds, etc., by which we call a thing to be new or old.)

Or "व्यावहारिक कालस्य परिणामस्तथा क्रिया ।
परत्वं चापरत्वं च लिंगान्याहुर्महर्षयः" ॥

—तत्वार्थसारः ॥ ३,४५ ॥

(The apparent time is known from the modifications (परिणाम) that it produces in substances and from the relations of the sun, the moon and the earth (क्रिया) and it is with the help of it that we determine (परत्व, अपरत्व) antecedence or non-precedence in time of substances and events.)

Or from *Panchastikaya Sar*, we have

"कालः परिणाम भवः परिणामो द्रव्यकाल संभूतः ।
द्वयोरेव स्वभावः कालः क्षणभंगरो नियतः ॥ १०७ ॥

(Apparent time is determined by changes or motions in things. The changes themselves are a result of Real or Absolute Time. The former has a beginning and an end, while the latter is eternal. The idealistic thinkers both in the east and in the

west* regarded time as a mere appearance. Vedánta has no explanation to offer for Time and the Vaisheshik school regards time as merely the principle of change and not an actual substance (see *The Hindu Realism*, p. 29). It is referring to such doctrines that the author of *Chandraprabha Charitam* has said :

"क्रिया दिनकरादीनामुदयास्त मयादिकाम् ।
प्रविहाया परः कालो नास्तीत्येके प्रचक्षते ॥" १८,७५ ॥

(According to some there is no other time except that which consists of acts comprised by the rising and the setting of the sun.)

Then in contradiction of this view the author writes :

"तन्न युक्त क्रियायां हि लोके काल इति ध्वनि : ।
प्रवृत्तो गोणवृत्यैव बाहीक इव गोध्वनिः ॥
न च मुख्याद्दते गौण कल्पना नरसिहवत् ।
तस्माद्द्रव्य स्वभावोऽन्यो मुख्यः कालोऽस्ति कश्चन"॥१८,७६-७७॥

(Though in ordinary language, the word 'time' is used to connote such acts (*i. e*, the rising or the setting of the sun) but real time is quite different from it. There is a time having the characteristics of a reality behind apparent time)

We shall speak more about Time as a Reality under Sutra 39. For the present we shall confine our attention to the functions discharged by the Time substance. The characteristic function of

*See *Kant's Philosophy as rectified by Schopenhauer* by M. Kelly.

Absolute Time is Vartaná (वर्तना). Vartaná has been explained as follows:

"प्रतिद्रव्य पर्यायमन्तर्नीतैक समया स्वसत्तानुभूतिर्वर्तना ॥"

—तत्वार्थ राजवार्तिक ५।२१।४

Or "अन्तर्नीतैक समया प्रतिद्रव्य विपर्ययम्।
अनुभूतिः स्वसत्तायाः स्मृता खलु वर्तना ॥"

—तत्वार्थसार ॥ ३,४१ ॥

Or from *Sarvarth Siddhi*

"वर्तते द्रव्य पर्यायस्तस्य वर्तयिता कालः ॥"

i. e., Vartaná is the perception of the continuity of existence of a substance understood from the changes produced in it in separate moments of time. For instance, if a quantity of rice is boiled on fire, from the instant that we put the pot on the fire slow changes go on continuously till it is boiled. Throughout this period the perception of existence of rice is inferred. This is called Vartaná. It is true that the inference of the existence of real time is to be drawn from the existence of apparent time as in the case of the boiling rice.*

Thus we see that the substance, which enables things to continue in nature or that which helps other five Realities in their continuity, is called Time by Jains. Just as the central iron pin of the potter's wheel is necessary for its revolving, so is time necessary for the 'revolution' of substances in nature. The question may be asked. If Time is the substance

* "सानुमानिकी व्यावहारिक दर्शनात् पाकवत्।"

—राजवार्तिक ।५।२१।५।

which assists things in their movements of continuity on what does Time itself revolve ? But the question is untenable. If Time were to depend on another substance for its continuance, the latter would require another substance to depend on and the chain would be interminable. It follows, therefore, that time exists by itself, and the things *continue to be* as a function of time.

In the *Key of Knowledge* by C. R. Jain, p. 758, we read the following forceful arguments in favour of Time as a substance:—

"It is obvious that no philosophy which ignores the elements of continuity and succession can ever succeed in solving its mystery (that of Time). Most of the philosophies of the world have taken it to be synonymous with succession and, consequently, failed to understand its true nature. Some have even gone the length of eliminating it from the list of existing substances, forgetting that things continue and undergo changes of form only in Time, not otherwise In one of its aspects, then, Time is the source of continuity and in the other a kind of force which makes it impossible for things to leap over succession and orderliness, by making them travel, point by point, or step by step, on the path of evolution. Take away Time as an all-pervading force from the universe, replace it in the form of capsules of energy in the individuals and you destroy the possibility of succession, *i. e.*, orderly causation, at a stroke, since in a world without time things might well occur and vanish like the beautiful palace of Alladin of the Wonderful Lamp. Remove Time

altogether from the world and you stop its evolution instantaneously, since no world-process is conceivable where continuity and succession are both conspicuous by their absence. Thus, from one point of view, Time serves as the mainspring of the *perpetuum mobile*, and, from another, keeps back the impish chance from playing its uncanny pranks with men and things in the world."

At this stage one is reminded of the great French philosopher, Bergson, who declared to the world that time was a potent factor in the evolution of the Cosmos. He was of opinion that changes and modifications are absolutely impossible without time element and so is the view of the Jain writers.

The view of modern science with regard to the 'passing' of time is well expressed by Richard Hughes on p. 343 of *An Outline for Boys and Girls and for their Parents*.

"The only way in which you can tell future from past is that you will find more chance* and higgledy-piggledy in it! To take a simple case. Suppose I made a cinema-film, in which some children came into a tidy room and played about at random till it was thoroughly untidy and then left. Now it would be possible to show that film backwards—then you would see the children go into the room and romp about till it was thoroughly tidy—*but you would not believe it*, you would *know* the film was being run backwards. Well, the whole universe is a vast room, in which

*'Chance' here means 'Absence of orderliness'

innumerable energy is arranged. To muddle thoroughly such an enormous room will take many æons. But the process is slowly and inexorably going on; and it is this increase of muddle on the side of us, this decrease on the other, which we *feel* as a difference between past and future: this growing disorder which we call the "passing" of time."

It is this 'muddling' which has been connoted by that word 'परिणाम' (modifications) in the main Sutra and more clearly expressed in gáthá 570 of *Gommatsar* quoted on page 151.

Sutra 23.

"स्पर्श रस गन्ध वर्णवन्तः पुद्गलाः" ॥२३॥

(Sparsh rasa gandha verna vantah pudgaláh.)

(Pudgala or matter has four chief characteristics associated with it, *viz*, touch, taste, smell and colour.) In a standard Swĕtámbar work we read as follows:

"पोग्गले पंच वण्णे पंचरसे दुगंधे अट्ठफासे पण्णत्ते"

—व्याख्या प्रज्ञप्ति शतक १२ उ० ५ सू० ४५०

(Pudgala is characterized by five kinds of colour, five kinds of taste, two forms of smell and eight kinds of touch.)

Achárya Sakalkirti expresses the same view in *Vardhman Puran* as:

"वर्णगन्धरस स्पर्श मयाश्चानन्त पुद्गलाः" ।

Or in *Panchastikaya Samaysar*:

"वण्ण रस गंध फासा परमाणुपरुविदा विसेसा हि ।
दव्वादो य अणण्णा अण्णत्त पगासगा होंति ॥५२॥"

Eight kinds of touch have been described as

"मृदु कठिन गुरु लघु शीतोष्ण स्निग्ध रुक्ष स्पर्श भेदाः ।

—तत्वार्थ राजवार्तिक, सूत्र २३,७ अ० ५ ।

Soft, hard, heavy, light, cold, hot, smooth and rough.

Rasa (रस) is of five kinds:

"तिक्त कटुकाम्ल मधुर कषाया रस प्रकाराः ।"

—तत्वार्थ राजवार्तिक, ५।२३।८

Bitter., sour, acidic, sweet and astringent

Smell is of two kinds:

"गंधः सुरभिरसुरभिश्च ।"

—तत्वार्थ राजवार्तिक, ५।२३।९

Good smell and bad smell.

Colour of five kinds is described as:

"नील पीत शुक्ल कृष्ण लोहित भेदात् ।"

—तत्वार्थ राजवार्तिक, ५।२३।१०

Blue, yellow, white, black and red.

After describing these 20 attributes of matter, the author of *Sarvarth Siddhi* has added the following significant words:

"त एते मूलभेदाः प्रत्येकं संख्येयासंख्येयानन्त भेदाश्च भवन्ति ।"

(The foregoing 20 are the principal divisions. In fact each of these can be further sub-divided into finite, infinite and transfinite ways.)

Let us now discuss these properties from the scientific point of view. Sparsha (स्पर्श) in the case of perceptible physical objects can be interpreted as the nature of the external surface, which may be smooth or rough, hot or cold, hard or soft.

These four pairs of स्पर्श गुण or 8 kinds of touch mentioned above refer to the following four physical properties of modern science: Scale of hardness* (मृदु, कठिन), density (गुरु, लघु), temperature (शीत, उष्ण) and crystalline structure (स्निग्ध, रूक्ष).

The relative hardness of substances is determined by scratching one with the other. For instance, a piece of copper can be scratched with a piece of steel or a sheet of glass can be cut with a piece of diamond, so we say steel is harder than copper or diamond is harder than glass.

Modern chemist has grouped all kind of matter into 92 forms of chemical elements, of which the densities vary from element to element. Hydrogen is the lightest and platinum or osmium are amongst the heaviest elements known. Taking water as the

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*In the Mohs' scale of hardness, substances have been arranged in the following order of increasing hardness.—

Talc, Gypsum, Calcite, Fluorspar, Apatite, Orthoclase felspar, Quartz, Topaz, Corundum and Diamond.

All these ten are naturally occurring crystals. The list shows that the diamond is the hardest known substance. Besides this instruments have been developed for measuring the infinite degrees of varying hardness in things. Scelerometer of Pfaff and Micro-scelerometer of Jagger are the chief instruments employed for a description of which see "Crystallography and Practical Crystal Measurement" by A. E. H. Tutton (Macmillan).

standard substance, gold is about 19 times heavier volume for volume and osmium about 23 times. But as we have referred on p. 17 *ante* forms of matter thousands of times denser than the densest substance on earth have been discovered in the interior of stars.* Just as in the case of hardness it is impossible to prepare a list of the infinite variety of substances of varying shades of hardness, so is found to be the case with densities of materials. The density of matter in nebulae is extremely thin—of the order of 10^{-24}, *i. e*, $\frac{1}{1000000000000000000000000}$ of the density of water.† On the other hand, there are stars in which the density of matter is of the order 620 tons per cubic inch, *i. e.*, 38440000 times denser than water. The same view has been expressed by H. Ward in a more mild tone thus.

"There are stars whose volume is a hundred million times that of our sun, composed of matter a million times less dense than the matter of our sun ‡ Also there are stars composed of matter two

*"Astronomical evidence seems to leave practically no doubt that in the so-called "white dwarf" stars the density of matter far transcends anything of which we have terrestrial experience; in the companion of Sirius, for example, the density is about a ton to the cubic inch"

—*The Nature of the Physical World*, Eddington, p. 203.

†*The Internal Constitution of the Stars*, Eddington, p. 332

‡The mean density of the sun is only 1 3 relative to water.

thousand times as dense as gold, so that a pint of it would weigh nineteen tons.''

—*Exploring the Universe, p.* 11.

When one compares the thinnest piece of matter existing in nature with the thickest, the above figures show that the latter is 38440000000000000000000000000000 times denser than the former. What surprise is there therefore when a Jain Achárya declares " प्रत्येकं संख्येयासंख्येयानन्त भेदाश्च भवन्ति " that the 20 attributes of matter have got a finite number of divisions from one point of view and an infinite number from another. If we regard matter in the form of 92 elements of the modern chemist, the attributes also assume a finite number, otherwise it is impossible to prepare a full catalogue of variations.

The third pair of attributes is शीत उष्ण. From a practical point of view when we speak of a body as feeling hot or cold we refer to its temperature. The range of temperatures existing in Nature is again very wide, and what little has come under the measuring rod of a physicist has revealed very striking contrasts. The temperature of ice physicists call zero and the temperature of boiling-water 100 degrees (Centigrade). The temperatures of bodies colder than ice are called minus temperatures and mathematical calculations show that the lowest possible temperature in Nature cannot be less than minus 273 degrees. Mercury hardens into a solid mass at minus 40 degrees. Just as the steam is converted into liquid water on cooling, so is air by artificial cooling converted into liquid air at minus

190 degrees. Helium gas is converted into liquid or solid helium at minus 269 degrees. Some other interesting temperatures are:

Gold melts at .	.. 1,062	degrees.
Platinum ,, ,, ..	.. 1,770	,,
Tungsten ,, ,, .	.. 3,400	,,
Temperature of burning charcoals	.. 1,300	,,
Temperature of electric carbon arc.	3,500	,,
Surface temperature of the sun	.. 5,500	,,
Central temperature of the sun	..two crores	,,

Highest temperature estimated in stars by Eddington four crores of degrees.

(See *The Internal Constitution of the Stars*, by Eddington.)

If we probe into our own atmosphere we find that the temperature gradually falls as one goes higher up until at about a height of 11 miles just over the equator temperature has a value minus 55 degrees— a temperature well suited to petrify even mercury. Further on up to a height of 23 miles the temperature remains steady, beyond which it increases to that of spring season, *i. e*, about 30°C. This is enough to show that temperature of things is measurable from one point of view and the infinite shades of it, it is impossible to enumerate. The extremes of temperatures existing in the regions of the Hell are expressed in the following verse of **छह ढाला** :—

"गिरि सम लोह गलै जमजाय, ऐसी शीत उष्णता थाय"

(Rocks of iron melt and freeze, such are the extremes of temperature in the hells.)

The last physical property which can be determined by touch is the smoothness or roughness of

the surface of a body which fundamentally depends upon the arrangement of crystals in the surface. When a metallurgist examines the surface of a piece of steel under a microscope, he sees a hotch-potch arrangement of crystals which is responsible for the physical nature of the outer surface. It shows that the arrangement of crystals in things can assume infinite number of ways, although for practical purposes these groupings have been classified.

We shall now discuss the five kinds of taste:

Bitter, sour, acidic, sweet and astringent.

Bitter (तिक्त) like quinine.

Sour (कटु), the result of unripeness in fruits.

Acidic (अम्ल) the taste of an acid such as the sulphuric acid or the tartaric.

Sweet (मधुर) like sugar.

Astringent (कषायला), the taste of red chillies.

These are physical properties associated with matter and should not be confounded with the well-known षट रस associated with articles of food. The latter are:

दूध, दहीं, घी, शक्कर, तेल, नमक.

(milk, curd, ghee, sugar, oil and salt.)

Winifred Cullis, professor of physiology at the London School of medicine and Dr. E E Hewer in their article on physiology* describe the organ of taste as follows:

"We taste with the minute projections that can be seen with a lens on the surface of the tongue.

* See page 81 of *An Outlines for Boys and Girls and Their Parents*

These projections carry sensitive cells that are in connection with nerve fibres. Four tastes can be distinguished—salt, sweet, sour and bitter: sweet things are best appreciated at the tip of the tongue and bitter things at the back."

It appears that the learned doctors had never the opportunity of tasting red chillies, otherwise there would have been no difficulty in recognizing the astringent taste of these as quite separate from the four tastes enumerated by them.

In recent years chemists* have been trying to find out the cause of this difference in taste. They have already investigated the cause of sweetness and have found that a particular arrangement of hydro-carbon elements is responsible for the sweetness. When work on this subject is pushed on further it is very likely that five different groups of elements which produce the five kinds of tastes mentioned above, will be discovered.

Coming to the subject of smell, there can be little dispute about the most arbitrary division: good and bad smell. We smell with the help of the special hair cells at the back of the nose covering an area of about one sq. inch. In a dog the area of the cell is 10 sq. inches and in the case of a shark 24 sq. inches; hence their unusual powers of smelling.

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*Read the article "Taste and Chemical Constitution" by A.J. Mee., M. A., in "Science Progress," October 1934. In this article the author has clearly recognized five kinds of taste. Says he "In taste there are only five general classes—sweet, bitter, salt, sour and insipid" This agrees quite well with the Jain view.

When the hair cells move by the impact of air reaching from outside, we perceive the smell. That smell is associated with every bit of matter is well illustrated by the phenomenon of 'Tele-olefaction.' An instrument called the Electro-olefactory* cell has been designed which is "much more sensitive than the human nose and can detect the smell emitted by a burning of a small rag 100 yards away." With its help smell of flowers, etc., can be transmitted along the wires or by wireless from one place to another over a distance of 65 miles. This apparatus has been further used to operate any automatic fire control, so that if fire breaks out, say, in a cotton godown, the smell of fire reaches the electro-olefactory cell which, with the help of certain electrically worked levers, opens a spray of water, thus extinguishing the fire. The students of Vaisheshik school should note that there cannot be any clearer proof than this of fire emitting some sort of smell, which Jain writers have recognized. (See pages 78-79 *ante*.)

Lastly five kinds of colours have been associated with matter:

Blue, yellow, white, black and red.

Some people who make much of the seven rainbow colours are apt to be misled by the five colours of Jain philosophy associated with matter (Pudgala) but a little reflection will show that this enumeration of five colours is the most scientific and up-to-date. "As the temperature of a body is raised, it

*See the paper read by B. D. Virmani, Bombay, before the Science Congress, Calcutta, 1935.

emits first of all infra-red radiation, then red light, then yellow light, and finally white light. If we could obtain even higher temperatures in the laboratory, we could make bodies 'blue hot' as is actually observed with some of the stars."

—*A Text-book of Heat* by A. W. Barton, p. 361.

Also in another standard work on the same subject by Dr. M. N. Saha, F. R. S., and B. N. Srivastava, we read on page 341

"As the temperature of a body is raised, the colour emitted by it becomes more and more rich in waves of shorter wave-length. Some of the stars shine with a bluish white light which indicates that their temperature must be very high."

The infra-red rays, referred to in the above quotation from Barton's book, are the dark heat rays which do not produce the sensation of vision These rays are present in what appears perfect darkness to us The eyes of a cat or of an owl perceive with the help of infra-red rays, hence these animals can see in the dark Recently Messrs Ilford, Ltd., have developed photographic plates, sensitive to infra-red rays with the help of which photographs can be taken in utter darkness. So long as the temperature is below the Draper point, 525°C a body emits only infra-red rays, in other words, it appears dark or black. then the colour changes to red, then yellow, then white and finally blue It should be noted here that these colours are not pigmentary colours but the natural colours which any piece of Pudgala takes up at different conditions of temperature and they are only five and no more, *viz.*, black, red,

yellow, white and blue, which is identical with

वर्णः स पंच विधः। कृष्ण नील पीत शुक्ल लोहित भेदात् ॥ सर्वार्थसिद्धि, सूत्र २३.

Some are apt to think that green colour should not have been dropped out of the list of colours and black and white were unnecessary, since white is a mixture of green and red pigments and black means the absence of colours. While thinking in this strain it should not be lost sight of that the above five colours are not pigmentary. The three fundamental colours for a canvas painter are red, green, and bluishviolet from which any desired colour can be produced by mixing these three powders in different proportions, whereas in tri-colour printing on paper red, yellow and blue are the colours required. Even in the case of the colours of solar spectrum it can be demonstrated that if red light is cut off from the spectrum by an opaque screen and the remaining six colours then re-combined by a prism, the resulting light would be green, showing thereby that what appears to be green, is only white light minus red. Then there is also a distinction between a mixture of spectral colours and that of pigment colours. Blue and yellow light, when mixed, produce white light, whereas blue and yellow pigments, mixed together would produce a green paint. This discussion clearly shows that the above Sutra, describing the fundamental properties of matter, refers neither to spectral colours nor to pigmentary.

It may be mentioned in addition that the definition of 'colour' adopted by the Optical Society of

America (see Report of the Colorimetry Committee, 1922) is as follows:

"*Colour* is the general term for all sensations arising from the activity of the retina and its attached nervous mechanisms. It may be exemplified by the enumeration of characteristic instances, such as red, yellow, blue, black and white...."

It shows perfect agreement with the Jain view.

Heart leaps with joy at the sight of this exact coincidence in the classification of these natural colours. The study of Nature by our forefathers appears to be no less critical than the modern.

With regard to the infinite gradations of these five colours (*vide* p. 158 *ante*), one word may be said about the fundamental nature of colour. Just as a difference of wave-length* in sound produces difference of note, similarly difference of wave-length in visible light produces difference of colour. "It is usual to regard light as a wave-motion, each wave-length corresponding to a definite colour" (Max Born). The shortest light-waves that the human eye can see are the waves of violet light. As they increase in length one passes across the rainbow: violet becomes blue, blue becomes green, green becomes yellow, yellow becomes orange and orange becomes red. When they lengthen beyond that they become too long for the human eye to see and the

*Sound and light energies travel in space in the form of waves. The most common form of wave is one which is produced over the surface of a pond by dropping a piece of stone. The distance from one wave-crest to another is called the wave-length.

body appears dark. The red waves are only $\frac{1}{30,000}$ of an inch long whereas the violet waves are only half as long, *i. e.*, $\frac{1}{60,000}$ of an inch. The waves of other colours have lengths intermediate between these values. On the average it may be said that light waves have lengths about $\frac{1}{100}$th of the diameter of human hair, the latter being about $\frac{1}{400}$ of an inch. If a light-wave differs from another light-wave in length even by an infinitesimal amount (अनन्तवाँ भाग) they are said to belong to two different colours. Thus from this point of view the number of colours is truly infinite and so is the version of Jain Achàryàs as quoted on p. 158.

Sutra 24.

"शब्द बन्ध सौक्ष्म्य स्थौल्य संस्थान भेद तमश्छायाऽऽतपोद्योत-वन्तश्च ॥२४॥"

(Shabda bandha saukshmya sthaulya sansthána bheda tamashchháyá tapodyota vantashcha.)

शब्द-बन्ध-सौक्ष्म्य-स्थौल्य-संस्थान-भेद-तमः-छाया - आतपः - उद्योत-वन्तः-च पुद्गलाः भवन्ति ॥

Manifestations of Pudgala (Matter) take the form of sound, union, fineness, grossness, figure, divisibility, darkness, shade or image, sunshine and moonlight.

In the Uttarádhyayan Sutra of the Swetámbaris the idea of this Sutra together with that of the

previous Sutra is expressed in the following words :—

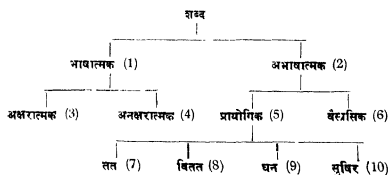
"सद्दन्धयार-उज्जोओ पभा छाया तवो इ वा ।
वण्ण रस गन्ध फासा पुग्गलाणं तु लक्खणं ॥१२॥
एगत्तं च पुहत्तं च संखा संठाण मेव च ।
संजोगा य विभागा य पज्जवाणं तु लक्खणं ॥१३॥ अध्या० २८

We have already referred to the scientific view of Jain Achárýás with regard to the production of sound on pages 89 and 90.

The following is the classification of sounds :

"शब्दो द्वेधा भाषा लक्षण विपरीतत्वात ।
भाषात्मक उभयथा अक्षरी कृते तर विकल्पात ।
अभाषात्मक द्वेधा प्रयोग विस्रसा निमित्तत्वात ।
तत्र वैस्रसिको बलाहकादि-प्रभवः ।
प्रयोगश्चतुर्धा तत वितत घन सोपिर भेदात ॥"

—तत्वार्थराजवार्तिक, अ० ५ सू० २४ (२,३,४,५,६).

Expressed in the form of a table, we have

(1) भाषात्मक—Sound incorporated in languages.

(2) अभाषात्मक—Sound which does not find place in any language.

(3) अक्षरात्मक—Articulate utterance or speech.

(4) अनक्षरात्मक—Sounds made by creatures or by the Kevalis.*

(5) प्रायोगिक—Sounds produced by human beings with the help of musical instruments, *i. e.*, musical sounds.

(6) वैस्रसिक—Natural sounds such as the roar of the thunder or the rippling of water and the noises in general.

(7) तत—Musical sound of the tablá (तबला) or the drum *i. e.* a stretched membrane.

"चर्म तनन निमित्त. पुष्कर भेरी वर्दु राादि प्रभवस्ततः"-सर्वार्थ सिद्धि, अ० ५ सू०२४.

(8) वितत—Musical sounds of stringed instruments.

"तंत्री कृत वीणा सुघोषादि समुद्भवो विततः—*Ibid*.

(9) घन—Musical sounds from reed instruments such as the harmonium or the xylophone. The sounds from bells are also included in this class

"ताल घंटा लालनाद्यभि घातजो घनः"—*Ibid*.

(10) सुषिर—Sounds produced from wind instruments, organ pipes or the conch.

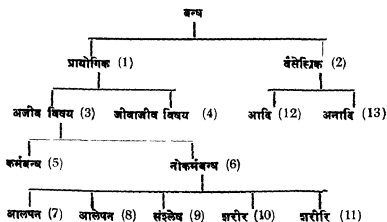
"वंश शंखादि निमित्त. सौषिरः"—*Ibid*.

---

*Kevalis are the persons who attain perfection of knowledge. Lord Pársva and Lord Mahávir are examples in recent times. It is said that their speeches were given in terms of a rythmic note generated by the vibration of the whole body which could be analysed by men and animals into their respective languages. It is difficult to find an exact analogue of this but it may be compared to the analysis of a complex wave-form of sound into its Fourier components by a harmonic analyser—a mechanical machine.

It is necessary to mention here that the Jain terminology for sounds of musical instruments is a bit different. For वितत they call तत and for तत, आनद्ध. See the following couplet from *Amarkosha*·

"ततं वीणादिकं वाद्यमानद्धं मुरजादिकम् ।
वंशादिकन्तु सुषिरं कांस्यतालादिकं घनम् ॥"

In modern accoustics the study of sound is divided into two main classes: Musical sounds and Noises. All the classes enumerated on p. 170 *ante* are included in Musical Sounds and class No. 6 (वैस्रसिक) includes the Noises. Noise is defined by modern science as the sound 'undesired by the recipient'. The sub-divisions of musical sounds include the vibrations of membranes, strings, rods and plates and air columns. These are respectively तत, वितत, घन and सुषिर. (See any text-book on sound.)
Union of matter has been classified as follows :

(1) प्रायोगिक (*Prayogic*)—Union produced by the efforts of the body, speech or the mind of a person.

(2) वसेरिक (*Vaisesrik*) — Union produced without any effort of a person.

(3) अजीव विषय (*Ajiva vishaya*) — Union of one kind of matter with another (chemical reactions belong to this class).

(4) जीवाजीव विषय (*Jivajiva vishaya*) — Union of matter with spirit.

(5) कर्मबन्ध (*Karma bandha*) — Union of Kármic matter with soul. (For Kármic matter read pages 91 *et seq.*)

(6) नोकर्मबन्ध (*No-karmabandha*) — Physical combinations.

(7) आलपन (*Alpana*)—As the fastening of a chain to a chariot.

(8) आलेपन (*Alepana*) —Painting over a canvas or mural painting.

(9) संश्लेष (*Sanslesh*)—Dovetail joints in pieces of timber.

(10) शरीर (*Sharira*)—Ligamentary joints of a living body.

(11) शरीरि (*Shariri*)—Union of two bodies.

(12) आदि वैस्रिसिक बन्ध (*Adi vaisrisik bandha*)—That which has a beginning and has resulted from a definite cause, such as the union of different colours in a rainbow. Production of lightning, the shooting stars, and the formation of the clouds are also included in this class. For we read in *Sarvartha siddhi* as follows :

"वैस्रसिक । तद्यथा-स्निग्ध रूक्षत्वगुणनिमित्तो विद्युदुल्का जलधारा-ग्नीन्द्र धनुरादि विषयः।" अ० ५ सू० २४

Tr.—The production of lightning due to the mixing of positive (स्निग्ध) and negative (रूक्ष) electric charges, the meteoric showers, the rainfall, the production of fire and the formation of the rainbow are examples of this class of combination in matter.

(13) अनादिबन्ध (*Anadibandha*)—Eternal union as the union of the different parts of substances like Dharma, Adharma and Akásha.

The other modifications of matter are सौक्ष्म्य and स्थौल्य, *i. e*, fineness and grossness The author of तत्वार्थराजवार्तिक says :

"सौक्ष्म्यं द्विविधं अन्त्यमापेक्षिकं च । तथा स्थौल्यम् ।" ५।२४।१४।१५

(Fineness and grossness are each of two kinds अन्त्य (extreme) and आपेक्षिक (relative).

Further from *Sarvartha siddhi*

"तत्रान्त्यं परमाणुनाम् । आपेक्षिकं बिल्वामलक बदरादीनम् ॥ स्थौल्यमपिद्विविधं, अन्त्यमापेक्षिकं चेति ॥ तत्रान्त्यं जगद्व्यापिनि महास्कंधे । आपेक्षिकं बदरामलक बिल्वतालादिषु ॥

(The parmánus furnish the example of extreme fineness in matter and *the universe itself constitutes the biggest molecule of matter* (महास्कंध). There is nothing smaller than parmánu and nothing bigger than the universe in the world of matter. Besides we talk of relative sizes for instance, jejubes are smaller than Bel fruit or a cocoanut is bigger than a plum and so on.)

संस्थान (Sansthán)* is the shape of a body ; it may be regular geometrical shape, circular, triangular or

*"संस्थानं द्वेधेत्थं लक्षणं अनित्थं-लक्षणं च । वृत्त त्र्यस्रचतुरस्रायतन परिमंडलादित्थ मतोन्यदनित्थम् ।" तत्वार्थराजवार्तिक ५।२४।१६,१७।

rectangular, etc., or it may be an irregular body as the shape of the clouds.

भेद (Bhed) means division. It is of six kinds :
'उत्कर-चूर्ण-खण्ड-चूर्णिका-प्रतराणुचटन विकल्पात्'' ॥ राजवार्तिक ५।२४।१८

उत्कर—Effecting separation as in sawing a piece of timber.

चूर्ण—As the grinding of wheat into powder.

खंड—As the separate parts of a broken pitcher.

चूर्णिका—As the separation of chaff from rice or pulses.

प्रतर—As the separation of layers in a sheet of mica.

अणुचटन—As the sm thereens of a blacksmith's workshop.

This appears to be a beautiful classification of the physical processes of dividing things into parts.

Tamah (तमः) is defined as "तमो दृष्टि प्रतिबन्ध कारणं प्रकाश विरोधि।"—सर्वार्थसिद्धि, ५,२४, *i. e*, it is the antithesis of light and is the cause of invisibility of things. Some people think that the existence of darkness should not be regarded as separate from light. They think that the negation of light is darkness. However it is not so. As indicated on page 166 *ante* even in perfect darkness infra-red rays exist and though they do not effect our eyes, they can be perceived by the eyes of a special photographic plate. Without the presence of these 'dark rays' photography in pitch darkness would have been impossible. So darkness has a separate existence from visible light.

About Chháya (छाया) we read as follows:

"छाया प्रकाशावरण निमित्ता । साद्वेघा, वर्णादि विकार परिणता प्रतिबिम्ब मात्रात्मिका चेति ।" —सर्वार्थसिद्धि, अ० ५ सू० २४.

On pages 88-89 we have considered the interpretation of Chháya. The author of the above commentary tells us that Chháya is of two kinds: Virtual images produced by a plane mirror which show the object laterally inverted, *i. e*, left side becoming right and *vice versa* and the uninverted images like shadows or the images of a modern cinema screen. The production of shadows is also correctly explained as due to the obstruction (आवरण) of light.

Lastly the division of light energy into two* categories; Atáp (आताप) and Udyota (उद्योत), is based on scientific considerations: Atáp is the sunlight or light of a fire, or electric lamp, etc, and Udyot, is the moon-light, the light emitted by the jewels or the phosphorescent light of the fire-fly.* The former predominates in heat rays and the latter in light rays. The efficiency of modern electric lamp is only 7%, and that of an arc lamp 15% In other words, only 7 or 15 per cent of energy is converted into light and the rest appears in the form of heat. Thus the light given by these sources has a much greater proportion of heat than light, and hence the name Atáp. The same is the case with the sun where only 35 per cent of the radiation appears in the form of light The efficiency of the tiny lamp in the body of the glow-worm is 99 per cent. In other words, the

*"आतपः आदित्यादि निमित्तः उष्ण प्रकाश लक्षणः"
"उद्योतश्चंद्रमणि खद्योतादि प्रभवः प्रकाशः" —सर्वार्थ सिद्धि ।

light given by a glow-worm contains 99 per cent of light rays and 1 per cent of heat rays; hence the most proper name given to it is Udyota. Surely this division reflects credit on the keen observation and discriminative power of the ancient thinkers.

Sutra 25.

" अणवः स्कन्धाश्च ॥ २५ ॥ "

Anavah skandhashcha.

(Matter exists in the form of indivisible elementary particles and their combinations.)

Some writers have translated anu (अणु) as an 'atom' and Skandha (स्कंध) as a 'molecule' of modern chemistry. We have already discussed the definition of an *anu* as given by Jain thinkers on pages 93 and 94 and pointed out that an *anu* is the last particle of matter which cannot be sub-divided any further by any means whatsoever. Hence it cannot be identified with the modern conception of atom although the word 'atom' originally meant something indivisible.

Following elementary particles are known to the modern science :--

1. Negative elementary charges called the electrons.
2. Positive elementary charges of the same mass called the positrons.
3. Positive elementary charges 1,850 times as heavy called the protons.

4. Elementary particles of matter without any electric charge and of a mass slightly less than that of the protons called the neutrons.

5. Heavy electrons, described in the foot-note on p. 111.

6. Neutrino—A particle of the mass of the electron but without any electric charge.

7. Negative elementary charge with mass equal to that of the proton, provisionally named as the negatron.

Nos. 6 and 7 have not been discovered as yet but their discovery at any future date is anticipated. As Prof. Max Born has said on p 266 of the "Restless Universe" the existence of first four is firmly established, "two light ones, the electron and the positron and two heavy ones, the proton and the neutron" He further adds that "these are too many. For it is likely that combination of

a proton and an electron	will give	a neutron,
a neutron and a positron		a proton.

Either neutron or proton must be composite"

Further on p. 275 of the same book we read that the nucleus of an atom is composed of protons and neutrons and the electrons and protons which occasionally fly out of the nucleus arise from the following transformations :—

Proton breaking into Neutron+Positron, and Neutron breaking into Proton+Electron.

These considerations show that the electron and the positron are the only *non-composite* elementary

particles of modern science and hence they can be identified with the two types of Parmánus described by Jain writers: the kárana parmánu (कारण परमाणु) and kárya parmánu (कार्य परमाणु). Shri Kundkundácharya writes in *Niyamsar*:

"धातु चतुष्कस्य पुनः यो हेतुः कारण मिति सज्ञेयः ।
स्कन्धानामवसानो ज्ञातव्यः कार्यं परमाणुः ॥ २५ ॥"

The idea of kárya and káran parmánus seems to be further supported by the following quotation from p. 265 of Professor Born's book:

"When light elements are bombarded by gamma-rays, electrons-pairs are observed to appear in the Wilson chamber, a positive electron and a negative electron shooting out from the same place." The question has been raised by the learned professor "Why is a positron always accompanied by a negative electron" and he says that the answer to this question has been given by the theory of Dirac. Since there can be no action (kárya) without cause (kárana) a kárya parmánu (positron) must always be accompanied by a kárana parmánu (an electron). The names seem to fit in very well.

The Vaisheshik school of philosophy also regarded atom as the final indivisible unit. "The mote which is seen in a sunbeam is the smallest perceptible quantity. Being a substance and an effect, it must be composed of what is less than itself; and this likewise is a substance and an effect, for the component part of a substance which has magnitude must be an effect. This again must be composed of what is smaller and that smaller thing is the atom.

It is simple and uncomposed, else the series would be endless and were it pursued indefinitely, there would be no difference of magnitude between a mustard seed and a mountain or a gnat and an elephant, each alike containing an infinity of particles."* This is the chain of arguments given by Rishi Kanáda in favour of an ultimate indivisible atom.

The author of *Panchastikuya Sar* defines a Skandha as "खंधो परमाणु संग संघावो" 'an aggregate of atoms'† and further in *Sarvartha siddhi* we read: "स्थूल भावेन ग्रहण निक्षेपणादि व्यापार स्कन्धनात्स्कन्धा इति सञ्ज्ञायन्ते ।" (The molecules possess a gross form and undergo processes of association and dissociation.)

Then the Skandhás are of two kinds वादर (those that can be perceived by the senses) and सूक्ष्म (those minute ones beyond sense perception) as enumerated in the following verse

"वादर सौक्ष्म्य गतानां स्कंधानां पुद्गलः इति व्यवहारः" ॥ ८२ ॥—पचास्तिकायसार.

With regard to Skandhás composed of only two elementary particles it said:

"अयोग्येष्वपि द्व्यणुकादिषु स्कन्धाख्या प्रवर्तते ॥"

(Although the power of uniting or separation is absent in combinations composed of only two elementary particles, they are still called Skandhás.)

The neutrons as belonging to this class have already been referred to on page 83 and

*Quoted from the *Key of Knowledge*, p. 22-23.

†Atoms in the sense described above, *i. e.*, an elementary indivisible particle.

a proton can also be looked upon as a combination of concentrated positive charges or a compound of neutrons and positrons. Strictly speaking such elementary particles belong to the class called Skandhapradesh See the following gáthá of *Gommatsar*, *Jivakanda*.--

' स्कंधं सकल समर्थं तस्य चार्धं भणन्ति देशमिति ।
अर्द्धार्द्धं च प्रदेशमविभागिनं चैव परमाणु ॥ ६०४ ॥"

The smallest piece of matter embodying all the characteristic properties of a substance is the complete molecule. Skandhadesh can be identified with modern atoms and dissociated molecules in solutions or the molecules in ionic state, Skandhapradeshás include the neutrons, the protons, the heavy electrons and the stripped atoms; and the parmánus are the electrons and the positrons. See also verses 80-81 quoted on p. 9 *ante*.

Another very striking and beautiful point mentioned in *Gommatsar*, *Jivakanda*, Gáthá 593, is

"पुद्गल द्रव्ये अणवः संख्यातादयो भवन्ति चलिता हि" ।

Elementary particles inside an atom and the molecules in a piece of matter are all in a state of motion. This is exactly the version of the modern dynamical theory and the electron theory of matter.*

*This view is further supported from Vartik 16, Sutra 7 of *Shri Tattvartha-raja-vartika* .

"पुद्गला नामपि द्विविधा क्रिया विस्रसा प्रयोग निमित्ता च ॥१६॥"

(Two kinds of motions are found in matter, one due to natural causes as in the case of the motion of the molecules in a gas or the motion of the electrons in atomic orbits and the other is generated by the external forces.)

The molecules are then further divided into 23 varganás, molecules composing the specialized physiological cells and others for details of which see S. B. J., Vol. V.

Sutra 26.

"भेद संघातेभ्य उत्पद्यन्ते ॥ २६ ॥"

(Bheda sanghátebhya utpadyante.)

Molecules are formed in three different ways;

(1) by Bheda (division),

(2) by Sanghát (union or sharing), and

(3) by the combined process of division and union taking place simultaneously

The advanced researches in physical chemistry have also revealed three processes of molecule formation We quote the following from an article "The Structure of Molecules" by A J Mee, M A , B Sc., appearing in the "Science Progress" (London), April 1935 —

"The question to be answered is, in what ways are atoms united in the molecule ? The electronic theory of valency is able to supply a very satisfactory answer. According to this theory, there are three methods of linking atoms The linkage may be electrovalent, co-valent or co-ordinate.....

"Molecules with an electrovalent linkage are ionised even in the solid state, x-ray analysis of the crystal indicating that the elementary particles making up the crystal lattice are ions and not atoms or

molecules....Nearly all inorganic salts are electrovalent compounds."

The second arrangement, *i. e.*, co-valent linkage is found in organic compounds. The atoms attain stability by a process of sharing electrons. For instance, in the case of the methane gas CH_4 the carbon atom attains a stable arrangement by sharing four electrons with the four electrons of the four hydrogen atoms. The third type of linkage, the co-ordinate linkage, involves the sharing of two electrons but both are supplied by the same atom. The process of the formation of a co-ordinate linkage *resembles both transference and sharing*. Therefore the three modern processes are transference, sharing and combined transference and sharing. The comparison is striking indeed !

Further the division of molecules takes place through the instrumentality of two causes : internal and external, for says the author of *Sarvartha siddhi*:

" द्वितय निमित्त वशाद्विदारणं भेदः "

The phenomenon of radio-activity, explained in pages 59 *et seq* and illustrated in Fig. 4, is an example of the breaking of a molecule (a modern atom) due to *internal causes* which even the scientists have not been able to elucidate. We read in the "Restless Universe," p. 238: "We may cherish the opinion that there must ultimately be some ***inner reason*** for the fact that one atom lives only a few seconds and its apparently identical neighbour many years; but no one has yet succeeded in putting his finger on the cause."

The examples of breaking under external stresses are four :

(1) Dissociation of molecules in solution

"The modern dissociation theory supposes that when the salt (copper sulphate) is dissolved some or all of its molecules are dissociated into $Cu^{\cdot\cdot}$ (copper) and SO_4'' (sulphate) ions, which move freely in the liquid; the molecules in this condition are said to be ionised." —*A Text-book of Physics* by R. S Willows, p. 396

(2) Thermal ionisation or breaking under high temperatures

Read pages 11-12 and 15-16 *ante*.

(3) Pressure ionisation or breaking under high pressures The phenomenon was discovered by Dr. D. S. Kothari—a Jain physicist of world fame

(4) Breaking under artificial bombardment.

Read pages 60 *et seq*.

Sanghát (संघात) has been defined as

" पृथग्भूतानामेकत्वापत्तिः संघात "

The union of separate entities is Sanghát: the assemblage of neutrons, protons and electrons to form atoms, atoms uniting to form molecules are examples of Sanghát

The joint process of Bheda and Sanghát is described as follows :

"भेद संघाताभ्यामेक सामयिकाभ्यां द्विप्रदेशादयः स्कन्धा उत्पद्यन्ते । अन्यतो भेदेनान्यस्य संघाते नेति ॥"—सर्वार्थ सिद्धि, अ० ५, सू० २६ ।

(By simultaneous separation and union molecules occupying two cells in space are produced. Just when one molecule breaks, the detached part attaches itself to another molecule.)

Compare this with the phenomenon of 'ionisation' in gases:

"The act of ionisation in gases really consists in the detachment of an electron from a neutral atom of the gas... . The detached electron soon attaches itself in a gas to a neutral atom." It is in this manner that positive and negative ions are formed.

Is not the coincidence surprising? Still one is apt to disbelieve that the phenomenon of ionisation in gases was known to the ancients.

Sutra 27.

" भेदादणुः " ॥२७॥

Bhedádanuh.

= भेदात्-अणु उत्पद्यन्ते

The ultimate elementary particles are produced only by division of matter (to an infinite extent—not by the process of union or fusion)

The same view is expressed in a fuller statement:

"अणोरुत्पत्तिर्भेदादेव, न संघातान्नपि भेदसंघाताभ्यामिति" ॥ सर्वार्थ सिद्धि ॥

The *anu* of the ancients is very clearly defined by the author of *Sarvartha siddhi* under Sutra 25 as below.

"सौक्ष्म्यादात्मादय आत्म मध्या आत्मान्ताश्च ॥ उक्तंच-अत्तादि अत्तमज्झं अत्तंतं णेव इंदिये गेज्झम् । जद्दवं अविभागी तं परमाणु विआणेहि ॥"

(Owing to its smallness in size, the *anu* is in itself the beginning and the end; it is beyond sense perception, *i. e.*, cannot be seen with the eyes and is the ultimate indivisible entity.)

And it is a fact that no instrument has been evolved by science so far, nor is there any possibility of its being evolved at some future date which would reveal before the eyes even the modern atom, what to say of *anus*, the ultimate elementary particles, the electrons and the positrons. This point is well brought out by John Pilley, Professor at Bristol University, under the sub heading " Do atoms really exist ? "*

" We can't see atoms either and never shall be able too. This is because light, though you would not think it, is made up of waves......ordinarily you think of light going in straight lines but actually it bends round corners a little just like sea waves do. This has the effect of giving everything you look at a tiny blur at the edge. But the blur is so narrow that you can never ordinarily see it. If you make a microscope to see extremely small things you find that you begin to see the blur. But, long before you get to the point where you would be able to see atoms the things you look at are entirely lost in the blur. *It is this that makes it impossible ever to see atoms*. Even if they were a million times bigger it would still be impossible to see them even with the most powerful microscope that has been made. "

The above quotation shows forcefully the truth of the statement 'णेव इंदिय गेज्झम्' (beyond sense perception) with reference to the parmánus.

*" An Outline for Boys, Girls and their Parents " (Gollancz) Section . Chemistry, p. 261.

We have already given arguments under Sutra 25 for identifying *anus* with electrons and positrons.

In *Panchastikaya Sar* the following properties are associated with parmánus—

" एक रस वर्ण गंध द्विस्पर्शं शब्द कारणमशब्दं ।
स्कंधान्तरितं द्रव्यं परमाणुं तं विजानाहि ॥ ८८ ॥

(The substance, which has a single taste, a single colour, one smell and two kinds of *sparsha* (cutaneous sensation), which is the cause of sound, itself unsounding, which is different from skandhás (aggregates of elementary particles and atoms), though constituting them, is the parmánu.)

According to Jain philosophy the full visual knowledge of the ultimate elementary particles of matter is a metempirical subject and can be the subject of experience of a person endowed with clairvoyant perception but since these are perfectly real entities five physical attributes out of the 20 mentioned on p. 158 are always associated with them.

As we have explained on p. 165 *et seq.* the natural colour of matter depends upon the temperature conditions and the latter vary from one piece of matter to another. For instance, an electron on the surface of the earth and one in the body of the sun or the star differ extremely widely in temperature and hence different colours must be associated with them. So it is said that one of the five colours enumerated before is associated with *anus* depending upon temperature. The *anu* has one of the five tastes (See p. 163.) and a smell, agreeable

or disagreeable. Then further it may be *Snigdha* or *ruksha*; these terms when applied to the elementary particles refer to the positive or the negative charge of electricity Thus one colour, one taste, one smell, temperature and the nature of electric charge are the five qualities associated with the tiniest piece of matter. The various combinations of these five attributes give rise to 200 different phases of elementary particles but identical in their intrinsic nature, which modern science identifies with grains of electricity.

It is further worthy of notice that the properties of hardness and softness, heaviness and lightness are not associated with *anus* by the Jain thinkers:

"Of the eight contact qualities hard and soft, heavy and light are the qualities of skandhás. These cannot be in the atom."—*Panchastikaya Sar*, p 86.

It is true that hardness and softness can be associated only with a little mass "molecule" of matter—a property which is generated by the loose or compact aggregation of parmánus, and because all parmánus, whether of the form electron or that of the positron, have the same mass there arises no question of light and heavy amongst the elementary grains of matter. This difference in mass is found only amongst the skandhás, the atoms of modern chemistry As is well-known the 92 kinds of atoms, each has a different weight, called the atomic weight For instance, if an atom of gold weighs 196, that of mercury 200.

Sutra 28.

" भेद संघाताभ्यां चाक्षुषः ॥ २८ ॥"

Bheda sanghátábhyám chákshushah.

(Molecules are sometimes produced by the combined action of division and union which can be seen with the eyes.)

Says the author of *Sarvartha siddhi*:

"अनन्तानन्त परमाणु समुदय निष्पाद्योपि कश्चिच्चाक्षुषः कश्चिदचाक्षुषः"

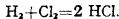
(Molecules composed even of an infinite number of elementary grains (parmánus) some of them are visible and some invisible.)

How the visible molecules are produced, the same author says

"सौक्ष्म्य परिणतः पुनरपरः सत्यपितद् भेदेन्य संघातान्तर संयोगात्सौक्ष्म्य परिणामो परमेस्थौल्योत्पत्तौ चाक्षुषो भवति"

(If a molecule breaks and the broken part then attaches itself to another molecule the resulting combination may be coarse enough to be seen with the eyes.)

Any number of illustrations can be given from text-books on chemistry. For instance, molecules of hydrogen and chlorine gas are invisible to the eyes but when each of them breaks and then combines to form two molecules of hydro-chloric acid, the thing becomes visible and even the molecules can be recognized through an ultra-microscope The reaction can be represented symbolically as

$$H_2+Cl_2=2\ HCl.$$

i. e. (Hydrogen mol. + chlorine mol = 2 mol. of hydrochloric acid.)

On p. 185 we have explained the phenomenon of ionisation of air. When a beam of X-rays is sent into an air chamber, air becomes ionised, *i. e.*, charged particles—positive and negative are produced by detachment and attachment of electrons and as in Millikan's famous oil-drop experiment, the 'handing on of these charges from molecules of gas to drops of oil and *vice versa* can be noted with the telescope' (Hutchingson). This is another example of the production of visible molecules (ions) by the combined process of division and union.

Sutra 29.

" सद् द्रव्य लक्षणम् "

(Sad dravya lakshanam .)

(The differentia of a substance or Reality is *Sat*, isness or being.)

Also in व्याख्याप्रज्ञप्ति श० ८ उ० ९ सत्पदद्वार we have

" सद्दव्वं वा "

(*Sat* is the characteristic of a substance.)

It should be noted, however, that the six dravyás of Jain philosophy, although possessing the common characteristic of *Sat*, are fundamental and cannot be intra-converted.

The following Sutra defines *Sat*.

Sutra 30.

" उत्पाद व्यय ध्रौव्य युक्तं सत् ॥ ३० ॥ "

(Utpáda vyaya dhrauvya yuktam Sat.)

Sat is characterised by the concomitant processes of *Utpada*, *vyaya* and *dhrauvya*. *Utpada* means com-

ing into existence—birth. *Vyaya* means going out of existence —death, and *Dhrauvya* means permanence. *Dhrauvya* is further defined in the following Sutra.

Sutra 31.

" तद् भावाऽव्ययं नित्यम् ॥ ३१ ॥ "

(Tadbhávávyayam nityam.)

Permanence means indestructibility of the essence or the quality of the substance.

The subject matter of these three Sutrás 29, 30 and 31 has already been sufficiently dealt with in pp. 65-71 and 99-103. In the former it has been explained and established on the authority of modern science that matter is constantly undergoing change, the new modifications appearing and the old ones disappearing and at the same maintaining its intrinsic nature through all these changes. This has been proved to be the fundamental characteristic of all matter. In the latter pages has been explained the way in which this characteristic is exhibited in non-material substances, the media of motion and rest, space and time, showing that *Utpada*, *vyaya* and *dhrauvya* are the intrinsic qualities possessed by all substances, material and non-material, if they are to be classed amongst the list of substances.

In the case of the soul substance, so long as it inhabits a corporeal body, it is always associated with grains of kármic matter (*see p.* 91 *ante*). As a result of changes in our thoughts, emotions and other activities old kármic matter is being continually shed off

the soul and an influx of new grains going on simultaneously, while the soul retains its essential qualities throughout these changes. This is called the पर निमित्त (par nimitta) kind of Utpáda, vyaya, and dhrauvya, *i. e.*, one which takes place through the agency of an external cause while the changes in Dharma and Adharma dravyás, etc., are of the स्वनिमित्त (Svanimitta) kind--without the aid of any external source.

Even in the case of a pure, disembodied soul Svanimitta kind of the three-fold phenomenon of origination, destruction and continuance goes on in thought-activity, since Jainism regards this phenomenon as the inevitable quality of a substance

We cannot conclude this commentary without quoting the words of Mr. V. R. Gandhi who spoke on this subject before the East India Association (London), on May 21, 1900:

"Noumenon and phenomenon are not two separate existences but only two modes of our looking upon the full contents of a thing, part of which is known and part unknown to us now. The fallacy in the popular mind in reference to these terms is that of confounding logical distinction with an actual separation. In the Buddhist view nothing is permanent. Transitoriness is the only reality. As Professor Oldenberg says: 'The speculation of the Brahmans apprehended being in all being, that of Buddhists becoming in all apparent being.'

"The Jains, on the contrary, consider being and becoming as two different and complementary ways of our viewing the same thing. Reality in the Jain view is a permanent subject of changing states. To

be, to stand in relation, to be active, to act upon other things, to obey law, to be a cause, to be a permanent subject of states, to be the same to-day as yesterday, to be identical in spite of its varying activities, these are the Jain conceptions of reality. Mere becoming is as much an abstraction as mere being. In short, being and becoming are complements of the full notion of a reality."

To many a mind the co-existence of this triple phenomenon may seem an obvious contradiction in terms but, according to Jain logic all contradictory statements are not necessarily hostile to one another (Syádváda theory of Jains). This idea is expressed in the following Sutra.

Sutra 32.

"अर्पितानर्पित सिद्धेः ॥ ३२ ॥"

Arpitánarpita siddheh.

(The determination of substances is done by giving prominence to their indestructible essence and giving a secondary place to their changeable conditions as it is necessary for their full consideration, because the permanent and the changeable aspects, though existing simultaneously, cannot be described simultaneously.

Similarly in other pairs of contradictory characteristics, one must receive primary and the other secondary consideration.)

—*J. L. Jaini.*

In *Sthananga Sutra*, a similar expression occurs:

"अप्पितणप्पिते" —स्था० १० सू० ७२७.

The author of *Sarvartha siddhi* has explained this in the following words:

"अनेकान्तात्मकस्य वस्तुनः प्रयोजन वशाद्यकस्यचिद्धर्मस्य विवक्षया प्रापितं प्रधान्यमर्पितमुपनीत मिति यावत्। तद्विपरीतमनर्पितं। प्रयोजना भवात्।"

Substances are endowed with an infinite number of attributes. When we describe a substance we can do so by adopting one point of view at a time so giving prominence to a few attributes. However it does not mean that other attributes are absent; what it means is that the missing attributes are of no purpose to us at that time.

For instance, we say that the universe is eternal from the point of view of the principles of conservation of mass and energy but it is not eternal from the view-point of entropy. Put in popular language, it means that the total amount of matter and energy in the Einstein's finite universe or in the finite Lokákásha of Jain philosophy will ever remain constant and hence the universe is *Nitya* or permanent From another point of view, the Second Law of Thermodynamics, the entropy of the universe is constantly changing. The various natural phenomena occurring spontaneously are tending towards equalization of temperature and pressure. According to this view everything is in a state of flux and a day would come when everything would be at a stand-still. From thsi aspect of thought we may say that the universe is non-permanent, ever-changing or transitory. These

two view-points although giving apparently contradictory results, are perfectly sane.

But this simple truth of Jain metaphysics has proved a stumbling block to many. What to say of the ordinary intellects, even the great geniuses like Shankaráchárya have failed to grasp its sense. For says he, "As thus the means of knowledge, the object of knowledge, the knowing subject, and the act of knowledge, are all alike indefinite, how can the Tirthankara teach with any claim to authority and how can His followers act on a doctrine the matter of which is altogether indeterminate ?"

Or says Prof. S. K. Belvalkar, "The dogmatic part of Jain philosophy........is altogether irreconcilable when taken in conjunction with its dialectical part *viz.* the famous Syádváda theory. As is well known, this theory denies the possibility of any predication : S may be or may not be or may both be and not be P With such a purely negative or agnostic attitude one cannot afford to have any dogma."

———*Undercurrents of Jainism.*

Let us therefore examine the proposition set forth by Prof. Belvalkar:

"S may be or may not be or may both be and not be P."

Strychnine is an alkaloid fatal to life. People have committed suicide by taking it internally. Nevertheless it possesses health-giving properties also and is prescribed by all medical men as a tonic. We therefore conclude that (1) Strychnine is a Poison from the view-point that it has killed several persons; (2) Strychnine is not a Poison from the view-point

that it has restored health in several cases of anæmia.

Hence Strychnine is a Poison and not a Poison at the same time. Hence there is nothing absurd in the symbolical statement:

S may be, may not be, or may both be and not be P.

To the question what S is generally, *i. e.*, in all cases, there can be no *direct* answer. We shall say it is indescribable (अव्यक्तम्).

To quote another example from the domain of physics, light energy behaves as a wave-motion from the point of view of the phenomena of interference and diffraction; it behaves like a particle from the point of view of the phenomenon of photo-electricity; sometimes it behaves as both. To the question what light is generally, no direct answer can be given. The language fails to put the answer in one word. It was for this reason that Sir William Bragg humourously remarked that on Mondays, Wednesdays and Fridays we regard light as a wave and on Tuesdays, Thursdays and Saturdays we regard it as a particle. Put it in sober language it means that although the nature of light when viewed from different aspects is contradictory, nevertheless this gives us the complete picture of the thing.

This is exactly the Jain view-point. In order to describe a thing completely it must be reviewed from seven different aspects. While enumerating its various attributes only one aspect can be given prominence at one time. If by so doing we arrive at apparently contradictory results, there is nothing to be afraid of or surprised at it. A substance is a

conglomeration of attributes, one may be prominent at one time and another at another.

The analogue, in modern science, of the theory of Syádváda, is the Einstein's famous theory of Relativity. Just as the theory of Syádváda was derided and ridiculed by the thinkers of non-Jain schools, so has been the fate of the theory of Relativity. Several mathematicians laughed and still laugh at the logic of relativity. Sydney A. Reeve, a veteran engineer, denounced the theory of Relativity in the "Nation" saying:

"In plain English, the Einstein theory is arrant nonsense, as bodiless a chimera as ever got a great nation on the run."* The philosopher Guggenheimer has written a book in which he argues that Einstein has made a very silly basic error in logic.

One may call Einstein or the whole host of leading physicists mere fools but the fact remains that "Relativity is probably the farthest reach that the human mind has made into the unknown............It is commonly thought of as metaphysical .. . .. (but)... it is so mathematical that only a few hundred men in the world are competent to discuss it." (Ward, p. 236.) The difficult nature of Relativity is beautifully narrated in the following story given by Prof. Max:o BJu

A friend of mine was once at a dinner-party and the lady next to him said: "Professor, do tell me in a few words what this theory of relativity really is." He replied: "Of course, I will—provided you will let me tell you this little story first. I was going for a

*Quoted from Ward's "Exploring the Universe," p. 257.

walk with a French friend and we got thirsty. By and by we came to a farm and I said: 'Let's buy a glass of milk here.' 'What is milk?' 'Oh, you don't know what milk is? It is the white liquid that——' 'What is white?' 'White? You don't know what that is either? Well, the swan——' 'What is swan?' 'Swan the big bird with the bent neck.' 'What is bent?' 'Bent? Good Heavens, don't you know that? Here, look at my arm: when I put it so, it's bent!' 'Oh, that is bent, is it? Now I know what milk is!'" After hearing the story the lady expressed that she is now no longer interested in Relativity.

However, leaving aside the mathematical aspect of the theory, its gist, in the words of Einstein himself, quoted by Mr. Bolton—an Englishman who won the Scientific American prize for the best exposition of relativity, is as follows: "*Relativity as a whole is the theory of the statement of general physical laws in forms common to all observers.*" The same writer continues to say "It is something of a puzzle why other writers of authority have not given fact a more prominent place and stated it plainly and explicitly. It may have been because it seemed so obvious as not to require emphasis, but to the writer's mind the greater part of the mystery, which has surrounded the subject, has arisen through failure to grasp it. It was certainly so in his own case When he realized it, the whole subject till then a hopeless jig-saw puzzle, seemed to arrange itself of its own accord."

He adds further on that "relativity describes ....the fact that the old laws of physics were not universally true; they were true only in the limited

sphere of inaccurate observation; they were merely relative. What the mathematicians have done is to derive formulas which shall be *universally true for all conditions of space and matter and motion.*"

Let us examine the expression "general physical laws in forms common to all observers," and the terms 'true' and 'universally true' in greater detail.

On pages 40-41 we have quoted an experiment of a man in a lift, falling freely in space and dropping an apple. There we have seen that for the man in the lift the force of gravitation does not exist while for the man on the street it does. In other words, one thing is true with respect to one observer and not true with respect to the other, since they observe it under different conditions. The theory of relativity attempts to express natural phenomena in terms of such mathematical formulæ that they may hold universally, *i. e.*, under all conditions. The mathematical language adopted by Einstein is analogous to the Avyaktavyam (अव्यक्तव्यम्) of the Syádvád philosophy. For instance, Einstein's law of gravitation asserts that 'the ten principal co-efficients of curvature are zero in empty space.' Can this law be expressed in a language understandable? The plain answer is No. It is indescribable in common parlance, *i. e.*, (अव्यक्तव्यम्). However when this law is analysed into its various aspects it gives all the results of common experience.

The *language of mathematics* is undoubtedly the most exact but the difficulty with it is that it cannot be *translated* into spoken language. For

instance, the portrait of a primitive man can be represented by the simple equation.—

$$y = 4 \sin x + \sin 5x.$$

and the thoughtful intellectual profile demands an equation of over 100 terms, *viz.*—

$$y = A_1 \sin x + A_3 \sin 3x + A_5 \sin 5x + \ldots + A_{(2n-1)} \sin (2n-1)x + B_1 \cos x + B_3 \cos 3x + B_5 \cos 5x + \ldots\ldots + B_{(2n-1)} \cos (2n-1)x,$$

where n should be greater than 50.

Other additional equations could be given to express the eye, the lips and the wrinkles*.

The question naturally arises, what is the necessity of employing such a language for the expression of natural laws. The answer is : Otherwise the same law reads quite differently when studied by different observers under different conditions or from different points of view. Now what is true of a particular law of Nature is also true of all statements in general. We have already discussed the statement : 'Strychnine is Poison' from different aspects and seen that we arrive at results apparently contradictory.

The case of a stationary conductor charged with electricity situated on the surface of the earth has been dealt with on pages xi-xii of the Prologue. There we have seen that there is no magnetic field round the conductor from the point of view of a person situated on the earth but there is a magnetic field round the same conductor from the point of view of a celestial observer. To the direct question : Is there a magnetic field round the conductor or is

*Quoted from F.M. Denton's "Relativity and Commonsense."

there none ? no answer can be given. How can the same body both give and not give a magnetic field at the same time? In the language of Jain Syádváda it is indescribable (अवक्तव्यम्). According to Einstein, "we can only know the relative truth, the Absolute truth is known only to the Universal observer."

The age-old controversy whether the earth moves round a stationary sun or the sun moves round a stationary earth was beautifully decided by the theory of relativity. Both may be right or both may be wrong depending upon the view-point which we adopt. We have no means at our disposal to decide between the counter statements or to determine the real state of things. The only thing which we can say is that the motion between the earth and the sun is relative* and 'in certain cases it is more convenient to relate the motion of heavenly bodies to the solar than to the terrestrial system.'

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*It is interesting to give a complete picture of the relative motions between the various components of the universe. Beginning with the smallest, the electrons are rushing with enormous speeds round the nucleus inside an atom, the atoms are vibrating inside the molecules, the molecules are executing harmonic motion even in solid bodies. The atoms and molecules compose the huge body of the Earth, the latter taking part in the *Gopi* dance of the solar system. In the solar system the Sun is the *Krishna* surrounded by planets, the *Gopis*, the latter whirling round the former. Even this pattern taken as a whole is not confined to one locality in space—the *Ras-mandal* (the dance party) is constantly shifting towards a fixed, point in the heavens, *viz.* λ—Herculis with a velocity of 4,22,000 miles per day. With regard to the nature of the dance it may be noted that not only are the *Gopis* dancing round the Sun *Krishna* but each is whirling round its own axis including the Sun himself. Then there are satellites or moons (at-

Referring to the relativity of direction Prof. Eddington writes. "A more familiar example of a relative quantity is "direction" of an object. There is a direction of Cambridge relative to Edinburgh and another direction relative to London, and so on. It never occurs to us to think of this as a discrepancy or to suppose that there must be some direction of Cambridge (at present undiscoverable) which is absolute. The idea that there must be an absolute distance between two points contains the same kind of fallacy. There is, of course, a difference of detail, the relative direction above-mentioned is relative to a particular position of the observer, whereas the relative distance is relative to a particular velocity of the observer. We

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tendants) attached to each *Gopi.* These are paying homage to their respective *Gopis* by going round them.

Now this *Ras-mandal* or our solar system forms but a tiny member of our Galaxy called the Milky Way The Milky Way, three hundred thousand light-years in diameter and ten thousand light-years in thickness and having a population of over 40 billion stars is also revolving about an axis directed towards a point in the Sagittarius star cloud. It takes 200,000,000 years to complete one revolution.

In the words of Prof. A. C. Banerji 'our galactic system is rotating like a cart wheel (चक्रनेमिक्रमेण) with this difference that the inner part of the wheel rotates more rapidly than the outer part Our sun is about 37,000 light-years away from the hub of this gigantic wheel which lies in a massive star cloud in the constellations of Ophiuchus and Scorpio....the sun and the stars in its neighbourhood attain a speed of about 200 miles per second due to the rotation of the galaxy alone" And what is our galaxy after all—one of a swarm of countless similar galaxies filling the whole universe. This is the complete picture of the relative motions of the members of our galactic system as known so far. The absolute motions it is impossible to determine.

can change position freely and so introduce large changes of relative direction but we cannot change velocity appreciably—the 300 miles an hour attainable by our fastest devices being too insignificant to count. Consequently relativity of distance is not a matter of common experience as the relativity of direction is. That is why we have unfortunately a rooted impression in our minds that distance ought to be absolute."

.—*The Nature of the Physical World, p.* 26.

We thus see that even such an obvious statement like 'The length of this table is 5 ft.' is a relative statement It may or may not be true or may both be and not be true depending upon the state of the observer. It may be true with respect to a stationary observer, may not be true with respect to a second who is in relative motion with respect to the first and carrying the measuring rod, for, as has been proved by Einstein a moving rod contracts* along the line of its motion.

Referring to this contraction, Professor Eddington on p. 33 of the same book raises the question "Is it really true that a moving rod becomes shortened in the direction of its motion ?" and he then adds: "It is not easy to give a plain answer. I think we often draw a distinction between what is *true* and what is *really true*. A statement which does not profess to deal with anything except appearances may be *true*; a statement which is not only true but deals with the realities beneath the appearances is *really true*."

*The contraction, however, is extremely small. For a speed of 19 miles per second contraction is 1 part in 200,000,000 or 2½ inches in a length of 8,000 miles.

Professor Eddington continues: "You receive a balance sheet from a public company and observe that the assets amount to such and such a figure. Is this true? Certainly; it is certified by a chartered accountant. But is it really true? Many questions arise; the real values of items are often very different from those which figure in the balance sheet. I am not especially referring to fraudulent companies. There is a blessed phrase "hidden reserves"; and, generally speaking, the more respectable the company the more widely does its balance sheet deviate from reality".

In the foot-note on page xi of the Prologue we have pointed out that 'true' and 'really true' refer to Vyavahár Naya and Nischaya Naya of Jain logic. These two Nayás (points of view) are defined as follows:

"तेनेदं भाष्यसंदिष्टं गृहीतव्यं विनिश्चयम् ।
तत्वार्थं निश्चयो वक्ति व्यवहारो जनोदितम् ॥"

—द्रव्यानुयोग तर्कणा । ८२३ ।

(Nishchaya point of view narrates the reality behind appearances and Vyavahár narrates things from a popular point of view.)

S. C. Ghoshal, M. A., B. L., writing on p. 7, S. B. J., Vol. I, says: "Vyavahára Naya is the ordinary or commonsense point of view in which we speak everyday about the things of this world. But Nishchaya Naya is the realistic point of view, which attempts an accurate description of realities which are overlooked in our everyday parlance. For example, we ordinarily say "a jar of honey" but

to be accurate we must say "a jar of clay or some other substance containing honey."

Consider another statement: "The weight of this body is 194 lbs." Is this absolutely correct? It may or may not be correct, for a weight of 194 lbs. at the equator weighs 195 lbs. at the poles. Apart from the position of the observer it also depends upon the state of the body, whether it is at rest or in motion.* It has been proved by Einstein and verified by several experiments that the mass of a body is variable and increases with the velocity of the body. Hence the statement under consideration is not true from all points of view. It will have different apparently contradictory answers when considered from different aspects.

In connection with the relativity of Time, Eddington examines the following statement: "If two people meet twice they must have lived the same time between the two meetings, even if one of them has travelled to a distant part of the universe and back in the interim." "If the question is pressed", he says, "most people would answer impatiently that of course the statement is true" but "it is well known both from theory and experiment that the mass or inertia of matter

*"Take body at rest. It has a definite mass. This is called the *rest mass* of the body. Assume now that this body is set in extremely rapid motion . . Will the mass of the body change? The classical physics answers this question in the negative. . The theory of relativity predicts not only that mass increases with velocity but also *in what way* mass depends upon velocity."

—*The World in Modern Science, p.* 80-81.

increases when the velocity increases. The retardation is a natural consequence of the greater inertia. Thus so far as bodily processes are concerned the fast moving traveller lives more slowly. His cycle of digestion and fatigue; the rate of muscular response to stimulus; the development of his body from youth to age; the material processes in his brain which must more or less keep step with the passage of thoughts and emotions; the watch which ticks in his waistcoat pocket; all these must be slowed down in the same ratio. If the speed of travel is very great we may find that, whilst the stay-at-home individual has aged 70 years, the traveller has aged 1 year He has only found appetite for 365 breakfasts, lunches, etc.; his intellect, clogged by a slow-moving brain, has only traversed the amount of thought appropriate to one year of terrestrial life. His watch, which gives a more accurate and scientific reckoning, confirms this...........the two men have not *lived* the same time between the two meetings."

Thus we see that the statement "If two people meet twice they must have lived the same time between the two meetings" is true from one point of view and not from another. It all depends upon whether both of them have been stay-at-home or one has travelled to a distant part of the universe and then came back in the interim.

It is on the relativity of length, mass and time that the magnificent structure of the Theory of Relativity has been raised and the miraculous results obtained as quoted on p. viii *f. n.* To

summarise what we have said in the foregoing pages, even the commonplace statements, *viz.*, the length of this table is 5 ft., the mass of this body is 174 lbs. or the age of a certain person is 70 years, are relative statements, *i.e.*, they may or may not be true depending upon the point of view.

As the modern theory of relativity has worked wonders in the domain of physics, so did Syádváda or Anekántváda (the philosophy of stand-points) produce revolution in metaphysical thought. It served as the key to unlock the doors of wisdom and the sole means of establishing uniformity amidst diversity of views. It aims to bring within a single fold the apparently divergent systems of philosophies by interpreting their truths from various stand-points. In the words of a great American thinker "It promises to reconcile all conflicting schools, not by inducing any of them necessarily to abandon their 'favourite' stand-points but by proving to them that the stand-points of all others are alike tenable or at least they are representative of some aspect of truth which under some modification needs to be represented and that the integrity of truth consists in this very variety of aspects, within the rational unity of an all-comprehensive and ramifying principle." (See *Nyayakarnika*, pp. 24-25) Jainism points out that the claim of different philosophies to represent the truth, the whole truth and nothing but truth is false. Each of them represents a partial truth. For instance, the old conflict between Dualism and Monism of Vedánta is pacified by Jainism saying that God is one from the point of view of Essence, from the view-point of being

Perfect, Pure Statushood of All-knowing, All-seeing, All-powerful, All-happy, etc., but from the point of view of manifestation He is not only many but infinite. There is nothing vague or indefinite in such conceptions, for they represent a synthesis of conclusions drawn from different stand-points, each conclusion being quite definite and clear in itself.

The same is the case with the laws of Einsteinian relativity. They embody as a part the laws previously deduced by Newton—the latter represent only one aspect of truth. Newton's laws do not hold when we consider natural phenomena on a microscopic or a macroscopic scale.

This establishes the great importance of the Sutra under consideration : "अर्पिता नर्पित सिद्धेः"।

Sutra 33.

"स्निग्ध रुक्षत्वाद्बन्धः ॥३३॥"

Snigdha rukshatvádbandhah.

=पुद्गलानां स्निग्धरुक्षत्वात् बन्धः भवति ।

The Pudgalás unite by virtue of the properties of Snigdha and Ruksha associated with them.

Also in Swetámbar granthás we have.—

""बंधण परिणामे....दुविहे पण्णत्ते —णिद्ध बंधण परिणामे लुक्ख बंधण परिणामे य—" ॥प्रज्ञा० परि०॥

As mentioned incidentally on p. 188 these terms* *snigdha* (स्निग्ध) and *ruksha* (रूक्ष) appear to have been arbitrarily used as the terms positive and negative have been used by modern electricians to denote the two kinds of electricity. This is further explained in Gáthá 615 of *Gommatsar Jivakanda*:

''स्निग्धस्य स्निग्धेन द्वयधिकेन रुक्षस्य रूक्षेण द्वयधिकेन ।
स्निग्धस्य रूक्षेण भवेद्बन्धो जघन्य वर्ज्यें विषमे समे वा ॥

A positive elementary particle combines with another similar particle differing in energy level by two units · Also a negative elementary particle combines with another negative elementary particle differing again in energy level by two units.

A positive particle can also unite with a negative particle and *vice versa*. Particles at the lowest energy level do not unite The union of the various particles of different energy levels may form an odd or an even series,—3, 5, 7, 9, etc., or 2, 4, 6, 8, etc.

A few examples are given below from modern science to illustrate these combinations :

The heavy electron, referred to on p. 111 *f. n.* has been formed by the union of electrons, *i. e.*, negative elementary particles of matter. If we call negative as Ruksha, this is a case of Ruksha combining with Ruksha.

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*One is likely to question as to what led us to identify Snigdha and Ruksha qualities of Pudgala with positive and negative electrifications. In support of our interpretation we quote the following words from *Sarvartha siddhi*

स्निग्धरूक्षत्व गुण निमित्तो विद्युत् —अ० ५ सू० २४

(Lightning discharge in clouds is produced by the qualities of Snigdha and Ruksha *i. e.* due to the development of positive and negative charges,)

In the "Science and Culture" for February 1938 we read that Prof. Eddington "from his theory, has predicted the existence of negatrons"—*i. e.*, particles as heavy as the protons but composed of negative particles or negative electric charges. We are strongly of opinion that *such a particle would be discovered* and it would serve another example of Ruksha particles combining with Ruksha.

The Snigdha combining with Snigdha is illustrated in the formation of protons. Positron is a snigdha elementary particle whereas the proton is a much bigger particle of the same kind. We venture to suggest that a proton has been formed by a close packing of elementary positive particles just as the close packing of protons gives rise to nuclear matter. (See pp. 16-17 *ante*.)

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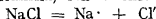
*Further discoveries of this kind have been announced in the 'Nature', April 16 and May 7, 1938.

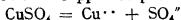
Williams and Pickup have obtained results which tend to confirm the existence of particles of mass intermediate between that of the electron and the proton in the cosmic ray streams Photographs showed the presence of particles of mass about 200 times that of the electron, carrying in some cases positive and in others negative charges One photograph indicated the presence of a particle of mass greater then 430 times that of the electron Street and Stevenson (1937) obtained results which could be explained by the existence of a negative particle with a mass about 130 times that of the electron. Nishina, Takeuchi, and Ishimiya (1937) obtained indications of the particles of both signs having masses about 1/7 to 1/10 of that of the proton, while Ruhlig and Crane (1938) considered that there were particles of mass (120±30) times that of the electron. This leaves no doubt about the combinations between snigdha and ruksha particles to form similar particles of higher atomic weights.

In all such cases—the union of electrons to form a heavy electron or a negatron, the union of positrons to form protons and the union of protons to form nuclear matter—the point is not clear as to why similar kinds of elementary particles should combine at all, since ordinarily two similar electrie charges do not attract each other but repel. This is explained by saying that the law of repulsion between two similar charges is changed into a law of attraction when the distance between the two particles is very very small. A similar case in gravitation has been pointed out on p. 121.

The structure of the neutron shows that it is an example of a Snigdha particle combining with a Ruksha particle—a proton combining with an electron in close union.

The nuclei of modern atoms are also an aggregation of positive and negative elementary particles and therefore serve as examples of Snigdha combining with Ruksha. The structure of an atom, as explained in pages 12-15, points in the same direction. In the formation of molecules from atoms we again see the union of Snigdha and Ruksha atoms. In Fig. 1 we have shewn a crystal of common salt (sodium chloride). It is composed of atoms of sodium and chlorine. When it is dissolved into water it dissociates into positive (Snigdha) ions of sodium and negative (Ruksha) ions of chlorine. The equation is

$$NaCl = Na^{\cdot} + Cl'$$

or in the case of Copper Sulphate (Nilá Tutiyá)

$$CuSO_4 = Cu^{\cdot\cdot} + SO_4''$$

(Dots are used at the top to denote Snigdha atoms and dashes to denote Ruksha.)

Referring again to Gáthá 615 of the *Gommatsar* quoted on page 209 *ante* we see that the necessary condition for union is that the combining particles or atoms should differ in energy level by two units. These units it is difficult to identify but it appears to be a sort of Exclusion Principle, and might, if properly interpreted, be used to explain the periodicity of the systems of the electrons in atoms, as does the Pauli's Exclusion Principle. There is no doubt, however, that there are various kinds of union differing in degrees of strength 'A question," said Sir Venkata Raman once, "of fundamental importance both to the physicist and to the chemist is, why do atoms combine to form molecules?" The learned professor then continues to say "we are not yet in a position to give a complete answer to this question. The facts of chemistry, however, compel us to recognize that chemical combination may be of different kinds. As an example of one type of chemical combination, we may instance the case of common salt. The elements sodium and chlorine when allowed to come in contact combine with explosive violence to form salt. Nevertheless when we dissolve common salt in water, there are excellent grounds for believing that the substance breaks up again into electrically charged atoms of sodium and chlorine respectively. We have quite a different type of combination when two atoms of the same element as, for example, oxygen, combine to form a molecule of the element.* When oxygen dissolves

*Sodium atoms combining with chlorine atoms is a case of Snigdha uniting with Ruksha, whereas two oxygen atoms combining to form a molecule of oxygen is a case of Ruksha uniting with Ruksha.

in water the molecule does not dissociate again into separate atoms.* The Raman Effect† enables us not only to distinguish between the different types of chemical bindings between atoms but also to go much further, and measure quantitatively the strength of the binding forces between the constituent atoms in a molecule." For instance, measurements of Raman effect, into the details of which we need not go, show that the structure of a molecule of carbon-di-oxide gas is of the form O=C=O, oxygen atoms are bound to the carbon atoms by double bonds, whereas the structure of a molecule of sulphur-di-oxide gas is of the triangular form as

where S stands for an atom of sulphur and O for an atom of oxygen. Notice further that the bonds are single in this case.

Sutra 34.

"न जघन्य गुणानाम्" ॥३४॥

Na jaghanya gunánám.

=न जघन्य गुणानाम् परमाणूनां बन्ध भवति ।

(The ultimate elementary particles at the lowest energy level do not unite at all.)

*It shows that in this case the bond between oxygen atoms is much stronger than that between sodium and chlorine atoms in a molecule of common salt.

†Sir C. V. Raman was awarded the Nobel Prize for the discovery of this effect.

In other words, we should expect to find electrons and positrons in perfectly free state as well and so it is. We quote the following from page 481 of *The Advanced Text-book of Magnetism and Electricity, Vol. II,* by R. W. Hutchinson :--

"Conduction of electricity in electrolytes and in gases is effected by positively and negatively charged carriers called ions. In liquids the ions are free charged atoms or groups of atoms; in gases the negative ion is an electron loaded up by having attached to it one or more neutral atoms (at low pressures the electron throws off its attendant neutral atoms and travels alone), whilst the positive ion is an atom which has lost one electron. The conduction of electricity in solids is also effected by carriers *but the latter in this case consist solely of free electrons*"

On p 485 of the same book the author adds that these free electrons in metals are not only responsible for the conduction of electricity but that "in the light of modern work there is every reason to believe that the electrons in the metals are the essential agents in the heat transference" also

Also the positrons have been found to occur in a free state in Nature. In fact their first discovery was made by Anderson in a stream of cosmic rays.

The Jain conception of different energy levels associated with the elementary particles of matter, *viz.*, electrons and positrons is confirmed from many sources. Referring to Pauli's exclusion principle Prof. Born says (p. 214): "An electron gas is supposed to exist in the interior of metals and to account

for their high conductivity. According to our former principles, we should have to give each of the electrons a name, Edward, John, George and so on. ......The extremely satisfactory discovery was made that the new Fermi-Dirac statistics applied to the electrons in metals gives much better results than the older theory." As mentioned on page 126 Fermi-Dirac statistics gives us a means of distinguishing between individual electrons having different energies.

Not only in the electrons but in the individual atoms also there is some distinction which certain phenomena seem to indicate but which science has not been able to elucidate so far. For instance, referring to the phenomenon of radioactivity Prof. Max Born says on page 238 of his book "The Restless Universe", "We may cherish the opinion that there must ultimately be some inner reason for the fact that one atom lives only a few seconds and its apparently identical neighbour many years; but no one has yet succeeded in putting his finger on the cause." This statement clearly shows that atoms do differ in some intrinsic property which Jain writers have given the designation 'the degree of Snigdhatva and Rukshatva (स्निग्धत्व and रूक्षत्व).

Sutra 35.

"गुण साम्ये सदृशानाम् ॥ ३५ ॥"

Guna sámye sadrishánám.

=न गुण साम्ये स्निग्ध रूक्षत्वानाम् सदृशानाम् परमाणूनाम् बन्धः भवति

Although the reading of this Sutra is exactly identical in Digambar and Swetámbar texts, the interpretation is not the same. According to the Swetámbars the interpretation is as follows :

Parmánus (the ultimate elementary particles of matter) with equal degrees of Snigdhatva or Rukshatva and of the same kind cannot unite with a parmánu of their own kind. In other words, an electron would not combine with another electron or a positron with a positron if both the particles are at the same energy level but an electron can unite with a positron or *vice versa* under the same conditions.

The Digambar interpretation is embodied in the following commentary by Achárya Vidyánandi in *Shlokovartika*, Sutra 35 :

"नन्वेवं विसदृशानां गुणसाम्ये बन्धप्रतिषेधो न स्यादिति न मंतव्यं, सदृश ग्रहणस्य विसदृश व्यवच्छेदार्थत्वाभावात् सदृशानामेवेत्यवधारणानाश्रयणात् ।

(It is not correct to interpret the Sutra saying that the elementary particles of opposite kind can unite even if the degrees of Snigdhatva or Rukshatva are equal This is not corroborated anywhere.)

Thus the main difference in the interpretation lies in the fact that while Digambars deny the possibility of union for all combinations of particles at the same energy level while the Swetámbars recognize such a possibility if the union is between particles of opposite kind. According to Digambars, the inevitable condition for union amongst elementary particles is expressed in the following Sutra

Sutra 36.

" द्वयधिकादि गुणानां तु ॥ ३६ ॥ "

Dvayadhıkádi gunánám tu.

According to Digambars this is equivalent to·

द्वि-अधिक-आदि गुणानाम् सदृशानाम् विसदृशानाम् परमाणूनां परस्परेण बन्धः तु भवति ॥

A positive or a negative elementary particle combines with another of a similar or a dissimilar type if they differ in their degrees of Snigdhatva or Rukshatva by two units.

The Swetámbars do not recognize this as a necessary stipulation for the union of the particles of dissimilar types.

It is difficult to interpret this Sutra strictly on the lines of modern science for certain reasons. We have pointed out before that the heavy electron, the mesotrons, or the negatron of the future can reasonably be looked upon as its being formed by the union of the ultimate particles, the electrons; similarly a proton can be thought of as made up of 1,850 positrons. In fact on pages 209-210 *ante* we have cited these as the examples of Ruksha combining with Ruksha and Snigdha combining with Snigdha particles. These operations of union appear to be carried out either in the deep interiors of the nuclei of the atoms or in certain secret corners of the interstellar space where physical conditions are favourable for such a union. Therefore it has

not* been possible to study the laws which govern such unions.

Let us, however, study the neutron of modern physics. It is formed by a very close union of a Snigdha particle and a Ruksha, the proton and the electron. In the hydrogen atom the electron goes round the proton forming a planetary system with dimensions of the order a hundred-millionth of a centimetre If the radius of the electronic orbit is made ten thousand times smaller, we arrive at the neutron model. The mass of the neutron is 'slightly less than the mass of the proton, because neutron is a stable system and part of its mass has been emitted during the process of its creation.'

Similar cases of mass-defect occur elsewhere also. For instance, the helium nucleus consists of four protons and two electrons Since the mass of an electron is negligible in comparison with that of a proton, the mass of a helium atom should be four times as great as the mass of the hydrogen atom *i. e.*, atomic mass of helium should be $4 \times 1 \cdot 0072 = 4\ 03$ while the measurement shows that it is only 4·00. This difference has been explained on the Einstein's

*On p 54 of *The New Chemistry* by Andrade the number of protons in the nucleus of an atom have been plotted against the corresponding neutrons. A glance at the figure shows that 'there is a valley of stability running across the diagram. ....Combinations well away from the valley are impossible.' Says the author of the book, "One of the problems of new chemistry is to find convincing reasons for this. In other words, what are the rules which will enable us to predict which combinations of protons and neutrons are stable, which unstable and which impossible? So far they have not been discovered."

principle of equivalence between mass and energy (read page 87 *ante*). Says Professor Infeld: "In the process of combining four protons and two electrons into the helium nucleus there disappear 0·03 units of mass. The simplest assumption is that the act of creation of helium from the tiny elementary constituents of matter is accompanied by the discharge of a proton projectile and that 0·03 units of mass are sent wandering through the universe in the form of energy of radiation........Eddington conjectures that in the laboratory of the universe in the vast inter-stellar voids in which innumerable fragments of mattei wander, and perhaps in the interior of stars where temperatures rule which are incomparably higher than any that can be realized on this earth—that in those distant regions there occur processes which are not observed on earth, that it is there perhaps that the process of creation of helium from the elementary constituents of matter—that is, from electrons and protons—takes place."

Further if we glance over the table of atomic weights of various isotopes* given on p. 155 of "Science in Modern World" by Infeld, we are struck by the round numbers differing by unity We reproduce below a part of the table:

Element.	Atomic weights of isotopes.
Neon	20–22–21
Magnesium ..	24–25–26
Silicon . ..	28–29–30

*Isotopes are atoms of different weights but of identical chemical properties.

Element.	Atomic weights of isotopes.
Sulphur	32–34–33
Zinc	64–66–68–67–65–70
Gallium	69–71

Note.—In the above table the isotopes are arranged in the descending order of frequency of occurrence. 21 comes after 22; it only means that the atoms of weight 22 are more abundant than the atoms of weight 21

This seems to support the Jain view that atoms have been formed by a definite law of union, a difference of two degrees of Snigdhatva or Rukshatva producing a difference of weight by unity.

Sutra 37.

"बन्धेऽधिकौ पारिणामिकौ च ॥ ३७ ॥"

Bandhedhikau párinámikau cha

=बन्धे अधिकौ गुणो पुद्गलो परमाणू वा स्कंधौ पारिणामकौ च भवतः

(In the process of union an elementary particle, an atom or a molecule with a higher degree of Snigdhatva or Rukshatva absorbs the one with a lower degree unto itself.)

The same view is expressed in Gáthá 619 of *Gommat Sar Jivakanda*

"स्निग्धेतर गुणा अधिकाहीनं परिणाम यन्ति बन्धे ।
संख्येयासंख्यानन्त प्रदेशानां स्कंधानाम् ॥ ६१९ ॥"

(In molecules of finite, infinite and transfinite atoms, the atoms with greater degrees of Snigdhatva or Rukshatva when uniting alter the atoms of lesser degree to their own kind.)

In Swetámbar text the Sutra reads as follows:

"बन्धे समाधिकौ परिणामिकौ"

=बन्धे सति समगुणस्य समगुणः परिणामको भवति अधिक गुणोहीनम्येति

As referred to on page 217 *ante* the Swetámbar text admits the possibility of union between dissimilar particles or atoms with equal degrees of Snigdhatva and Rukshatva the present Sutra is also modified in conformity with the previous view and it says that the union between dissimilar particles of equal degrees of Snigdhatva and Rukshatva will produce a neutral particle or an atom whereas in the union of an atom of a higher degree with one of a lower degree, the character of the latter.will be converted into that of the former.

In the formation of the neutron (see p. 94 *ante*) there appears to be a compromise between the Digambar and the Swetámbar views. The binding energies of the proton and the electron are very much different but the resulting atom is neutral (समगुणः)

"Each atom carries into its combination two things: first its own proper energy, and, second, the faculty of expending this energy in its own way, in attaching other atoms to itself, not indiscriminately, but in definite atoms and in definite numbers."—C. A. Wurtz (1869). The atom-fixing power of an element has been termed *valency* by the modern chemist. A. S. Couper (1858) called it the *affinity of degree*. For instance, the valency of an atom of nitrogen is one in N_2O, two in NO, three in N_2O_3, four in N_2O_4 and five in N_2O_5. The valency of an

atom of chlorine is one in HCl, four in ClO_2 and seven in Cl_2O_7.

"The differences in the valency of different elements have been explained by supposing that an atom of an n-valent element is compounded of n units, each of which is capable of attracting one other unit. A constant quantity of one element, said E. Erlenmeyer (1862), never binds itself to more or to less than a constant quantity of another element—this he called the *law of affinivalencies* A. W. Hofmann (1865) called the same, the minimum atom-binding quantities of an element." The Jains connoted this idea by the difference in the degrees of gunás.

It should be noted however that except in the case of ionized atoms (स्कंधवेश) (see p. 181 *ante*) the resulting molecule formed by the union of atoms is (समगुणी) neutral, neither Snigdha nor Ruksha. However in the process of ionisation, explained on page 185, it is easy to see how an electron by attaching itself to a neutral atom changes the latter into its own kind—a negative ion

How a Snigdha particle is changed to Ruksha or *vice versa* is seen very well in the example given above and in many others. Chlorine atom in HCl (hydrochloric acid) is Ruksha while the same atom in Cl_2O, is Snigdha; in the modern language they are called respectively electro-negative and electro-positive. Hydrogen atom in HCl is electro-positive while the same atom in sodium or potassium hydride (Na H or K H) is electro-negative. Many more such examples can be cited. Thus the truth enunciated in the Sutra is established.

Sutra 38.

" गुण पर्यायवद् द्रव्यम् ॥ ३८ ॥ "

Guna paryáyavad dravyam.

A substance is always associated with certain intrinsic and inalienable qualities called Gunás and it constantly changes its modes of existence called Paryáyás (modifications).

Commentary.

This universe of ours is constituted by six fundamental realities—Spirit (soul), Matter including energy, Space, Time and the media necessary for the operation of dynamic and static forces, the last two in the language of science being the luminiferous aether and the fields of force—gravitational and electromagnetic. But to define reality has always been a stumbling block with philosophers old and new.

The Jain philosophers have given a very satisfactory definition of 'reality' in Sutrás 29 and 30 and the same subject has been more fully discussed in pages 65-71 and 99-103.

In the present Sutra a substance has been defined in an alternate manner, since substances are many from another point of view. It says that a substance always possesses attributes and undergoes modifications. For instance, Matter possesses properties of touch, taste and smell while the soul substance is characterised by consciousness. The relation between the substance and its qualities, has, however, given rise to two different schools. "One always emphasises the permanent basis as the real and the other the

changing qualities. The former condemns change as mere appearance or Máyá, whereas the latter condemns the permanent substance as a mere figment of imagination. The former school generally ends in agnosticism and maintains that real is unknown and unknowable. The latter generally ends in scepticism and sweeps away in a flood of doubt the fundamental concepts of life and world, of morality and religion. In India we have Advait Vedánta as an example of the former and Buddhism of the latter. In the West, the philosophers, like Locke and Kant may be mentioned as representatives of the former school and Hume may be taken as a type of the latter." (Philosophical Introduction to *Panchastikaya Sar*, p. xxx.—A. Chakravartty.)

Even the great modern thinkers and scientists like Eddington have found it impossible to frame a suitable definition of a 'substance'. Referring to the present world, he says, "How shall I describe it ? It has extension; it is comparatively permanent; it is coloured; above all it is *substantial*. By *substantial* I do not merely mean that it is constituted of 'Substance' and by that word I am trying to convey to you some conception of its intrinsic nature. It is a *thing*; not like space, which is a mere negation;* nor like time, which is—Heaven knows what ! But that will not help you to my meaning because it is the distinctive characteristic of a 'thing' to have this substantiality, and I do not

*Space is not a negation but a real substance. This fact has been established in pages 141-143. The nature of time as a reality has been explained in pages 150-156 and more has been said in the following Sutra No. 39.

think substantiality can be described better than by saying that it is the kind of nature exemplified by an ordinary table. And so we go round in circles."

Sutra 39.

" कालश्च ॥ ३९ ॥ "*

(Time is also a substance.)

In the Swetámbar text the reading is:

" कालश्चेत्येके " =कालः च इति एके

भाष्यम् : एकेत्वाचार्य्या व्यावसते कालोऽपि द्रव्यमिति ॥

(According to some Achāryás, Time is also a substance.)

Achárya Siddhsengani regards Time as a modification of Jiva and Ajiva (soul and matter). In the Swetámbar work *Jivavigam* the same view is expressed but in *Bhagvati Sutra* and other standard works Time has been regarded as a separate reality. Achárya Umáswámi, the author of the present work, having first firmly established the characteristics of a reality in Sutrás 29, 30 and 38 finds that all the characteristics mentioned in these Sutrás are inherent in the entity called the Time and therefore now at this late stage he mentions Time to be a reality like the other five realities mentioned before, thus making the total number of fundamental realities as six.

We now proceed to investigate the nature of Time.

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*Read this Sutra in conjunction with Sutra 22.

As described in pages 150-154, Time is divided into two categories—Absolute and Apparent, *de jure* and *de facto*. The former is made up of Kálánus (grains or quanta of Time).* See Gáthás below :

" लोकाकाश प्रदेशे एकैकस्मिन् ये स्थिताः हि एकैकाः ।
रत्नानां राशिः इव ते कालाणवः असंख्य द्रव्याणि ॥२२॥" द्रव्यसंग्रह ।

Or " एकैकवृत्त्या प्रत्येकमणवस्तस्य निष्क्रियाः ।
लोकाकाश-प्रदेशेषु रत्नराशिरिव स्थिताः ॥३, ४४॥" तत्वार्थसार ।

Or " लोकाकाश प्रदेशे ये ह्येकैका अणवःस्थिता ।
भिन्न भिन्न प्रदेशस्था रत्नानामिव राशयः ॥१६, ३५॥" वर्द्धमान पुराण ।

(*Tr.*—Innumerable grains of Time reside, one in each space-point of the finite universe (Lokákásha), like heaps of jewels.)

In other words, the Time consists of units which never mix with one another but are always separate. The whole universe (excluding Aloka—the pure space beyond finite universe) is full of these grains of Time; no part of the space within it is devoid of them. These grains are invisible, without form and inactive, *i. e.*, in a static condition and countless in number. They have been compared with jewels to signify that they never mix or coalesce This characteristic differentiates Time from the other five substances; for, while the former consists of separate particles, the latter are collections of indivisible and inseparable parts. In the technical language of the Jains "कालस्य तु नास्ति कायत्वं ॥१०९॥ समयसार" ॥ *i. e.*,

* Grains or quanta of time, cells of space or space-points and ultimate indivisible particles of matter,—Kálánus, pradeshás and the parmánus are the distinctive conceptions of Jain thought confirmed by the researches of to-day.

Time has no spatiality or extensive magnitude. Extension is of two kinds, longitudinal Extension and multi-dimensional Extension called respectively ऊर्ध्व प्रचय (Urdhva prachaya) and तिर्यक प्रचय (Triyak prachaya). The existence of the grains of time can be represented by a mono-dimensional mathematical series and hence said to have only the longitudinal Extension. For this reason Time is not included in the list of Astikáyás. (For definition of Astikáya see p. 3 *ante*). The other five substances,—Soul, Matter, Space and Media of motion and rest,—require a series where each term of the first series is an item in the second. The latter is called a two-dimensional series and corresponds to the surface Extension or Triyak Prachaya.

The distinction between apparent and absolute or real time is given in Gáthá 107 of *Panchastikaya Sar* quoted on p. 152. The former has a beginning and an end while the latter is eternal. The scientists also suspect that there is a real time behind the apparent time. Says Prof. Eddington: "Whatever may be time *de jure*, the Astronomer Royal's time is time *de facto*.... You may be aware that it is revealed to us in Einstein's theory that time and space are mixed up in a rather strange way. This is a great stumbling block to the beginner." (*The Nature of the Physical World*, p. 36.) The mixing of space and time is well expressed in the Gáthás quoted above and in the following quotation from the *Sarvarth Siddhi*:

"लोकाकाशस्य यावन्तःप्रदेशाः तावन्तः कालाणवो निष्क्रिया एकैकाश प्रदेशे एकैक वृत्या लोकं व्याप्य व्यवस्थिताः"

[As many cells of space there are, so many kálánus or grains of time are located lying static, one in each cell, permeating every iota of Loka (the finite universe.)]

"One startling conclusion from Einstein's theory is that both space and time vanish away into nothing if there be no matter. We cannot conceive of space and time without matter. It is matter in which originate space and time and our universe of perception "* So is the conclusion of Jain thinkers: In the infinite pure space extending beyond Loka, no other substance exists but space; there is no matter and hence no grains of time. The resemblance is striking It is also true that human mind would fail to perceive space if there were no matter in it but since space is an independent substance, there is nothing to deny the possibility of its existence beyond Loka and as remarked in previous pages this idea of Loka and Aloka has solved a number of difficulties.

The Akáyatva (non-spatiality) of time is admitted by Eddington when he says. "I shall use the phrase time's arrow to express this *one-way property of time* which has no analogue in space. It is a singularly interesting property from a philosophical stand-point." —*Ibid*, p. 69

The Kálánus represent the physical time analogous to the "world-wide instants", as Eddington chooses to call them, existing in the four-dimensional world (*Ibid*, p. 102) The spatial and temporal

*P. 37 of the Proceedings of Physics Seminar, University of Allahabad: July 1925, Article on 'Relativity' by Dr. N. R. Sen.

relations of which Eddington speaks further on are these :

Every cell of space in the bounded universe has one Kálánu situated in it (spatial relation) and the continuous changes effected by Kálánus in their surroundings give rise to temporal relations.*

With regard to the infinity of time, Richard Hughes in his article on "Physics, Astronomy and Mathematics" says · "It follows from this that the time-dimension cannot come round full circle as we imagine space to do. By going far enough into the future we shall never reach the past. And yet it is not necessary to imagine that time either had a beginning or must have an end." The same is the verdict of Einstein's Cylinder theory quoted on p. 57. Eddington expresses the same view on p. 83 of his book when he says "The world is closed in its space dimensions like a sphere but it is open at both ends in the time dimension. There is a bending round by which East ultimately becomes West but no bending by which Before ultimately becomes After." The learned professor then adds "But the difficulty of an infinite past is appalling . We have been studying the running-down of the universe; if our views are right,

*Newton's conception of time was different from the present day conception. He regarded Time, Space and Matter as independent entities. According to this view time would continue to go on even if the whole universe contracted to a point. The Jain view widely differs from this but agrees completely with that of Einstein who regards time as a separate entity but inseparably mixed with space, so much so that time has been regarded as a dimension like the three dimensions of space.

somewhere between the beginning of time and the present day we must place the winding up of the universe...... There is no doubt (about) a date at which either the entities of the universe were created in a state of high organisation or pre-existing entities were endowed with that organisation which they have been squandering ever since." This is all true : the running-down of the universe is called by Jains the Avasarpni Kála (unwinding of the universe at a slow rate comparable to the pace of a snake) and the gradual rewinding is called the Utsarpni Kála at the end of which the things are in a state of high organisation. These processes are going on from an infinite past into an infinite future, and consequently there should be no difficulty in imagining infinity of time.

However the reality of time is admitted on all hands. Eddington remarks on p. 275 of his book that "Time is more typical of physical reality than matter." Says Mr. Henshaw Ward in "Exploring the Universe", "These four elements (Matter, Space, Time and Motion) are all separate in our minds; we cannot imagine that one of them could *depend on* another or be converted into another." Prof. N. R. Sen, D. Sc. (Cal.), Ph. D (Berlin), says in the same article quoted before ; "Time, in classical mechanics, is regarded as a continuously flowing entity absolute in nature. This idea of time is involved in all mathematical analysis and is perfectly self-consistent. But what about the physical time which we measure in our laboratories ? A little consideration would show that this cannot be absolute but depends on the condition of the observer."

With regard to the smallest unit of physical time it may be mentioned that Jain writers have given it the name Samaya* which is defined as follows:

"द्वयोरण्वोरतिक्रम काल प्रमाणं भवेत स तु"॥ —गोम्मट्टसार जीवकांड गाथा ५७३॥

(The time taken by one parmánu (the electron or the positron) in traversing the distance between two of them placed side by side in space is called the *Samaya.*)

The biggest unit of time is the Mahákalpa (महाकल्प) made up of two aeons, avasarpni and utsarpni, each consisting of

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(77 digits) solar years. (The Brahma Kalpa of Hindus also consists of 77 digits but the digits do not agree.)

Then there are intermediate units of every day use.

Thus time as an independent reality is established on modern evidence.

Sutra 40.

" सोऽनन्त समयः ॥४०॥ "

So anant samayah.

(An infinitesimal fraction of time is called the *Samaya.*)

This Sutra defines the unit of time. Just as *Parmanu* is the unit of mass and space-point or the *Pradesh,* the unit of three-dimensional space, similarly a *Samaya* is the unit of time and is

*Unit of pudgala is parmánu, unit of space is pradesh or the space-point and so the ultimate unit of time is the Samaya.

defined as the time taken by a *Parmanu* to traverse one space-point or the time taken in going from one *Kalanu* to another. Since there is only one *Kalanu* in each space-point, the two definitions are identical.

Sutras 41 and 42.

" द्रव्याश्रया निर्गुणा गुणाः ॥ ४१ ॥"

Dravyáshrayá nirguná gunáh.

" तद्भावः परिणामः ॥ ४२ ॥"

Tadbhávah parinámah.

(1) Attributes can never exist independently of the substances of which they are the attributes and one attribute cannot be the substratum of another attribute.

(2) The change in the character of attributes of a substance is called parinám (modification).

The same view is expressed in *Panchastikaya Sar*, Gáthá 13.—

" द्रव्येन विना न गुणा गुणैर्द्रव्यं विना न सम्भवति ।
अव्यतिरिक्तो भावो द्रव्य गुणानां भवति तस्मात् । "

(There can be no quality without substance or substance without quality, the two are inseparable in their nature.)

According to Jains, dravya is a dynamic reality having a continuous flow parallel to the flow of time. It cannot be thought of apart from its qualities which in their turn are not separate from the

dravya. In other words, qualities can only reside in substances and substances are bundles of qualities. One cannot think of fluidity apart from a fluid. The difference between a substance and its attributes is not a difference of existence but only that of reference.

The triple nature of reality, *i. e.*, continuance through origination and destruction gives to a substance a characteristic mode of existence every moment.

The modifications which the six dravyas undergo have been divided into two classes. Arth paryáya (**अर्थ पर्याय**) and vyanjan paryáya (**व्यंजन पर्याय**). All the six dravyas have the former but the latter is associated with spirit and matter only. The former refers to the intrinsic changes in dravyas while the latter has a somewhat fixed duration of existence. For instance, a pot is a vyanjan paryáya of matter, similarly men and animals are vyanjan paryáyás of the soul substance. Read also pages 99-102 in this connection.

In the Swetámbar text the following three Sutrás occur in addition:

" अनादिरादि मांश्च "

" रूपिश्वादिमान "

and " योगोपयोगौ जीवेषु "

(The modification may be of eternal or transient nature. Eternal changes occur in non-corporeal dravyas, Soul, Space, and Media of motion and rest. Modifications in matter are of transient nature.

Digambars have also contributed to these ideas in the commentary *Tattvarth-raj-vartika* with some modifications but we omit a detailed description because of their little importance.

This brings us to the end of our journey.

THE SUMMARY.

ACCORDING to Jain Cosmology the universe comprises of six Dravyás, Substances or Realities. A dravya, substance or reality has been defined as any substantiality or existence which has the important characteristic of persistence through change, *i. e.*, it undergoes a transformation and re-appears in a new form while the original substantiality still abides. Also a Reality is the basis in which attributes rest and modifications take place.

The six realities are: (1) The Soul, (2) Matter, (3) Space, (4) Time, (5) a Non-material medium for the motion of souls and the propagation of matter and energy, and (6) the Field through which the gravitational and electro-magnetic forces operate for maintaining the unity of the microscopic as well as of the macroscopic worlds.

The number of substances is fixed as six; it can never be seven or five. These substances are eternal and unchanging in their characteristics. Leaving aside the substance matter all others are non-material and formless and hence devoid of all properties associated with matter.

For explaining cosmical and physical phenomena the three *fundamental units* of space, matter and time have been chosen corresponding to the units of length, mass and time *i. e.*, the C.G.S. or the F.P.S. systems of modern science. The unit of space is called the *pradesha* (space-point) and is defined as the space

occupied by one indivisible particle of matter and capable of being occupied by even an infinite number of such particles under abnormal condensations. The unit of matter is the *parmanu* (the smallest indivisible particle of matter,—the electron, negative or positive) and the unit of Time is the *Samaya* (समय), which is defined as the time required for a *parmanu* to traverse one space-point

The Soul.

The soul is the reality which possesses the faculty of knowing and perceiving, in which the sensations of pain and pleasure inhere and through which the volition functions. Modern experimental psychology has already discovered the electrical counterpart of the soul, called the *Taijas-Sharir* (तैजस-शरीर). The soul has the potency of changing its size by contraction and expansion. It can occupy the smallest possible body of a bacteriophage or the biggest body of a whale fish. Although the soul substance is non-quantumistic in nature, one single soul can fill every iota of space in the whole universe under special circumstances. Since a body grows from a microscopical size in the mother's womb to its full proportions and contracts again, at the end of its earthly career, to re-incarnate into a new seed, it follows that the size of the soul cannot remain fixed. Modern science identifies life with protoplasm or the living cell and it is well-known that protoplasm possesses a remarkable property of contraction under external stimuli. Soul experiences pain, pleasure, life and death through the agency of kármic matter. This theory of transmigra-

tion of soul is an extraordinary conception found in no other system of thought. According to this view, all actions of embodied living beings, whether mental or physical, are followed by an influx of fine molecules of energy towards the soul, the latter constituting what is called kármán body. To use the modern language, the activities of mind and matter constitute a super-radio, with the quintillions of living cells sending out their individual waves to be tuned in by quadrillions of receiving sets in the brain. Influx of these waves is the influx of subtle kármic matter. Kármic matter, we can call *the fourth state* of matter, the other three being *Solids*, *Liquids* and *Gases*. Activity of a good kind attracts meritorious while activity of a bad kind attracts the opposite kind of kármic matter. The kármic body is responsible for dragging the soul from one physical body to another, and it keeps the soul bound to the confines of the universe owing to the gravitational forces operating on all sides. When kármic matter is shed off the soul by following the Path of Liberation, the latter, being the lightest substance, rises up to the top of the universe and rests there as Pure Effulgence Divine. It cannot travel further on owing to the absence of luminiferous aether beyond, aether being the necessary medium for motion.

The Media of Motion and Rest.

The Jain philosophers recognized in the world life, matter and space but these were not enough. There could be no stable world if there were nothing to prevent the souls and atoms from flying about

and being scattered throughout the infinite space. This led to the hypothesis of a *medium of rest*, the *Field* through which the binding forces operate. But if there were the Field alone there could be no motion at all in things and bodies. There would be an eternal paralysis of Reality. To remove this difficulty another *medium of motion* had to be postulated. But the trouble is not yet over. If the two media exist within a spatial limit one guaranteeing motion and the other rest, then the things in motion must be in motion for ever and things at rest must be there for ever. But our experience is not of that kind, and therefore it is assumed that the two media are inactive and neutral in themselves, yet indispensable to the composition of the world. They are non-material, non-atomic, and continuous media pervading every iota of the whole universe, although for purposes of practical convenience they are regarded as made up of space-points. But they possess the characteristic properties of a Reality, *viz.*, they undergo a cycle of changes, old forms gradually disappearing, new forms appearing and at the end of the cycle the original pattern is again there. In fact a stationary wave-motion, explained in pages 101-102 of the text, is constantly taking place in these invisible media, as if the heart of the whole universe were throbbing in tune with the Almighty. As every student of physics knows there are nodes and antinodes (places of no disturbance and maximum disturbance) in a system of stationary waves, who can say that the positions of nodes (slight swellings at which the leaves arise) and internodes (smooth parts between

the nodes) in the stems of plants are not determined by the positions of the nodes and the antinodes in the media of motion and rest ?

The modern analogue of the medium of motion is the aether. It is undoubtedly regarded as the medium through which electromagnetic waves travel. In the beginning the scientists associated material properties with aether which gave rise to serious difficulties and contradictions. However the idea of aether, after suffering many cataclysms, survives to this day. It is now regarded as an imponderable fluid surrounding every particle of matter and penetrating every atom and the molecule. Physicists made various assumptions about aether in order to explain the electromagnetic phenomena, *viz.*, that (1) moving bodies carry aether along in their motion, (2) moving bodies do not carry aether with them but they only move in a calm aether-sea, or (3) aether is partially carried and partially not carried by the moving bodies. But all these assumptions miserably failed to explain facts and were contradicted by the most delicate experiments. Neither motion *of* aether nor motion *through* aether could be detected. The reason probably is that aether does not possess any of the properties associated with matter. We would like to point out that Jain physics postulates the existence of stationary waves in aether and this assumption needs to be worked out mathematically. It is a new idea and may lead to fruitful results. Even to this day the aether problem remains a great puzzle and we read on page 184 of *The Evolution of Physics*: "All our attempts to make aether real failed......After such

bad experiences, this is the moment to forget the aether completely and to try never to mention its name. We shall say; our space has the physical property of transmitting waves and so omit the use of a word we have decided to avoid. The omission of a word from our vocabulary is, of course, no remedy. Our troubles are indeed much too profound to be solved in this way!" A similar trouble was anticipated by the Jain thinkers when they asked the question: What is the harm if we associate the functions of motion and rest with the space which exists everywhere? (See p 135 *ante.*) And the answer given was: By so doing the division between the finite universe and the infinite space beyond would disappear. It is interesting to note that if we regard our universe as infinite, it cannot be stable at the same time, for in that case all our energy would get scattered into the infinity of space and the attractions of myriads of other universes filling the infinite universe on our universe would scatter it into infinity. In order, therefore, to maintain the stability of our universe running from an infinite past into an infinite future the universe must be conceived as of finite dimensions so that when the energy travelling with the velocity of light, 1,86,000 miles/sec., reaches the confines of the universe it gets reflected and is not lost. The total energy of the universe will in this case remain constant. Einstein introduced this idea of finite universe by making the odd postulate that space gets warped under the stress of matter. The idea of the space becoming curved due to the presence of matter and thus closing in to form a finite universe

is a hard pill to swallow. Jains also regard the universe as finite* but the cause of this finite-ness is more easy to comprehend. According to Jain view there are no media of motion and rest beyond a certain limit called the Loka and consequently matter or energy can never get out of this limit with the result that the total energy of the universe remains constant throughout eternity. The pure mathematical space extending to infinity beyond without the presence of any grain of matter or time is called the Aloka.

As we have already remarked the modern scientific equivalent of the 'medium of rest' is the *Field* through which the forces which maintain the cosmic unity operate. Without this medium there would be no coherent system of souls and atoms, there would be only chaos—no world would be possible. The Field is similar to aether in so much as it is also a non-material, invisible, non-atomic, continuous and passive medium but its function is just opposite. These two media interpenetrate in every bit of the universe and do not interfere with the functions of each other. It is a case similar to that of the co-existence of electrostatic, magnetostatic and gravitational fields, which, although of different character, do not mix; each preserves its individuality regardless of the other. For instance, if both electric and magnetic poles are at rest, there is no

*The volume of the universe, according to Jains, is 343 cu. rajjus, a rajju being a quantity of the order 10^{21} miles. (See p. 117.) The use of the word *Brahmanda* (ब्रह्माण्ड) (universe of the ellipsoidal form) by Hindus for the universe is also suggestive of the finitude of the latter.

action between them, neither attraction nor repulsion. In the language of science this would be expressed by saying: an electrostatic field does not influence a magnetostatic one and *vice versa*. The discussion of pages 139-40 will show that the scientists are still in doubt with regard to the true nature of the Field. They are making the mistake of associating material properties with this non-material medium and hence the whole jumble.

In conclusion, it is worthy of notice that although all Indian philosophies have devoted very great pains to the theories of world evolution, none of them but the Jains could think of these vital principles of motion and rest without which a stable world structure is impossible and incomplete.

Akasha or the Space.

According to Jain philosophers the term **Akásha** means the mathematician's pure space and not the primeval substance of the Hindus out of which the Creation was evolved. The chief function of space is to accommodate the infinite physical objects, living-beings, the media of motion and rest, and the time. The space is divided into two main divisions: the Lokákásha, which is co-extensive with these objects and the Alokákásha or Anantàkàsha, which is pure space extending to infinity beyond Lokákásha. In the Infinite Beyond there are no objects animate or inanimate. Not a tiny molecule of matter nor a stray soul would step beyond the limits of the Loka. The system of objects is held together by the static and the dynamic principles, the aether and the Field and

these principles are confined to Lokákásha. We have already explained in the last section why the functions of motion and rest cannot be associated with space. According to the views of modern science the total amount of matter which exists is limited and the total extent of the universe is finite. The totality of space is so curved that a ray of light, after travelling in a direct line for a long enough time, would come back to its starting point. A ray of light would, according to a rough estimate, take about ten trillion years for the round trip in the totality of curvature. Einstein connects the curvature of space with the amount and distribution of matter in the universe. Space, if there be matter inside it, bends round until it closes up. The more matter there is, the smaller space there must be and space could only be of literally infinite extent if it contained no matter at all. Just as the surface of a sphere is a curved surface and a closed surface enclosing a three-dimensional volume, so is our three-dimensional space a curved space and a closed space enclosing a four-dimensional continuum. One startling conclusion from Einstein's theory is that both space and time vanish away into nothing if there be no matter. We cannot conceive space and time without matter. It is matter in which originate space and time and our universe of perception. It should be noted that while Jain philosophy regards only part of the universe as finite and an infinite pure space beyond, Einstein regards the whole universe as finite with nothing beyond it, although it is quite inconceivable that there should be no space beyond a certain space. When Professor Eddington declares

that the physicists cannot in any case conceive of space as void, it is clear that they do not believe in *space as a substance in itself.* Our view is that space is a real eternal substance, for pure expansion is not thinkable in the absence of a substance in which it might inhere. Space without matter and time is not void.

The Time or the Kala.

Jain philosophy regards time as one of the six fundamental realities of the physical universe. Time is divided into apparent and absolute time. Apparent time is that which assists substances in their continuing to exist, is the auxiliary cause of different kinds of modifications in them and is measured by some conventional units of longer or shorter durations The absolute or real time, existing behind apparent time, consists of innumerable grains, called the *kalanus*, residing one in each space-point of the finite universe, the Lokákásha, like heaps of jewels. These grains never mix or coalesce with one another; they are invisible, formless and inactive. The time substance differs from the other five substances in one important respect and it is this: Time is unidirectional. This *one-way property* of time has been given the name, time's arrow, by Eddington. Time has only a longitudinal extension, no spatiality and hence no indivisible and inseparable parts called the pradeshás or space-points. The instants of time, *i. e.*, Kálánus are so arranged in space that their arrangement can be represented by a mono-dimensional mathematical series, *i.e.*, a series of linear order. This characteristic

distinguishes time from the other five entities which require a multi-dimensional series to represent their surface extension. In Einstein's theory the space and time are mixed up in a strange way. According to this theory we cannot conceive of space and time without matter. According to the Jains also the grains of time are mixed up with space, one kálánu (the quantum of time) in each space-point, lying static and permeating every iota of the Lokákásha (the finite universe). In the infinite pure space extending beyond Lokákásha, no other substance exists but space; there is no matter and hence no time also. Newton regarded time, space and matter as independent entities. According to him time would continue to go on even if the whole universe contracted to a point. The Jain view widely differs from this but agrees completely with that of Einstein. With regard to the infinity of time the Jain view supports Professor Eddington's following statement: 'There is a bending round by which East ultimately becomes West but no bending by which Before ultimately becomes After.' In other words, time has neither a beginning nor will it ever come to an end.

The Pudgala or Matter and Energy.

The sixth and the last entity composing the physical universe is what is called by Jains, 'the Pudgala'. It is worthy of note that the use of this word is quite peculiar to the Jain philosophy; it does not even exist in the dictionaries edited by non-Jain writers. The physical manifestations of Pudgala are the matter and energy. The root-meaning

of the word Pudgala is: 'the entity which manifests itself in various forms by the processes of combination and disintegration'. One who is familiar with the modern developments in atomic physics cannot but admire the choice of the word Pudgala to denote matter and energy. We now know full well that all atoms are an assemblage of electrons, protons and neutrons. In the phenomenon of radio-activity atoms are seen disintegrating themselves of their own accord into others and in the phenomenon of artificial radio-activity bombardment by alpha particles, protons or neutrons brings about such transformations as the conversion of aluminium or sulphur atoms into those of phosphorus. Figs. 5 and 6 of p. 61 show beautifully how a foreign alpha particle bullet fills an empty place in the nucleus of a nitrogen atom and produces an atom of oxygen. Similarly Fig. 7 of p. 62 shows how a foreign proton bullet gets embedded into the nucleus of a lithium atom and completes the alpha particle. At the same time the nucleus bursts and the two alpha particles fly in opposite directions. It is therefore a case of the processes of combination and disintegration following in rapid succession. Fig. 8 of p. 63 is interesting. An alpha particle is shot into the nucleus of an atom of beryllium metal with the result that the shot is absorbed, beryllium is converted into carbon and the neutron is ejected out of the original nucleus. Here also the processes of combination and partial disintegration are playing their role. Many more such examples can be multiplied. As we shall see later the molecules are

formed by the atoms by similar processes of division and union. Thus the use of the word Pudgala for matter and energy fully justifies itself.

The chief characteristic of the substance Pudgala is that it is the subject of sense perception; it has a form, in contrast with the other five constituents of the universe which are without form. The physical properties of hardness, density, temperature and either positive or negative charge are associated with it. It has one of the five tastes: sweet, bitter, sour, saltish or astringent; a good or bad smell and one of the five colours, black, red, white, yellow or blue depending upon the temperature. Not only in the gross form of matter are these physical properties associated but the Jain Achâryâs have extended them to the ultimate particles of matter also. As mentioned on p. 187 every *parmanu* (electron or positron) has one of the five tastes, one of the five colours, a good or a bad smell and a positive or a negative electric charge. Matter is divided into six sub-classes: Solids, Liquids, Gases, Energy, fine kârmic matter and extrafine matter consisting of the streams of the ultimate particles of matter. Until some sixty years back the classical physics of Newton and Galileo regarded energy as perfectly weightless and without any association with matter. It was the genius of Einstein who definitely proved that every form of energy has mass and that there is no difference between matter and energy but that of the form. It is really wonderful to note that this truth was already discovered several centuries ago by the Jain philosophers. They regarded every form of energy as a manifestation of Pudgala, and

hence one form of energy could be intra-converted into the other. It is really interesting to see that, whereas in the history of modern science the nature of heat, light and electricity could not be elucidated for a long time, heat and electricity being regarded as fluids for several centuries, they were already known as modifications of energy to the Jain thinkers several millenniums ago*.

Matter is then thought of as made up of Skandhás (molecules), Skandhdeshás (atoms), Skandhpradeshás (ionised or stripped atoms) and parmánus (invisible elementary particles such as the electrons and the positrons). In conformity with the version of the modern kinetic and electron theories of matter, the Jain philosophy also regards elementary particles inside an atom and the molecules in a piece of matter to be in a state of motion. (*Vide* p. 181 *ante.*) With regard to the formation of molecules three processes are enumerated by the Jains, *viz.*, division, union and the combined process of simultaneous division and union, corresponding to the electro-valent, co-valent and co-ordinate methods of linking atoms in modern science. The breaking up of molecules† is attributed to two different causes, internal

*The true nature of sound was also known to the Jain thinkers Unlike the other Indian systems of thought which associate sound with aether or space (Akásha), Jain system explains it as being due to the vibrations of the molecules Sound is further divided into Musical sounds and Noises and the musical sounds produced by the vibrations of strings, reeds, pipes, bells and stretched membranes are given different names (See pp. 170-172).

†According to the Jain view, the modern atom is in fact a molecule and the author of the present work makes bold to say that the Raman effect which is characteristic of molecules *will some day be discovered* in the modern atoms also, thus bringing them into the category of the molecules.

and external. The phenomenon of radio-activity is an example of breaking up due to some internal cause and dissociation of the molecules in solution, the thermal and pressure ionisations and breaking under artificial bombardment are examples of breaking due to external causes. The phenomenon of ionisation is described as due to the simultaneous separation and union of the molecules. 'Just when one molecule breaks, the detached part attaches itself to another molecule', says the author of *Sarvartha Siddhi*. The formation of the mechanical mixtures of matter and that of the chemical compounds as a result of reactions were known respectively as *No-karmabandha* (नो-कर्मबंध) and *Ajiva Vishayabandha* (अजीव विषयबंध). Coming to the subject of extra-fine matter, the sixth and the last division, as quoted on p. 93 *ante*, it is defined as composed of skandhás made up of one or two parmánus and no more, and parmánu is the last particle of pudgala which cannot be sub-divided by any means whatsoever. The parmánus are of two kinds called the kárya parmánu (कार्य परमाणु) and the káran parmánu (कारण परमाणु) which have their modern analogues in the electron and the positron. These names are very significant in the sense that there can be no kárya (action) without káran (cause) and as such they should occur in pairs. This is supported by the fact that when light elements are bombarded by gamma-rays electron-pairs are observed to appear in the Wilson Chamber, a positron and an electron shooting out simultaneously from the same place. The other elementary particles like the neutrons, protons, negatrons and the mesotrons have

all been formed by the union of these two types of parmánus according to certain laws.

The union of the electrons and the positrons to form different kinds of matter is attributed to the differences in the degrees of Snigdha and Ruksha properties of these particles. As mentioned on p. 209 *f. n.* the discharge of electricity between the clouds has been attributed, by the author of *Sarvartha Siddhi*, to the same property of Snigdhatva and Rukshatva. Referring to the phenomenon of atomic-interlinking Dr. B. N. Seal in his book *The Positive Sciences of the Ancient Hindus* (London), suspects that 'the crude but immensely suggestive theory of chemical combinations (of the Jains) is possibly based on the observed electrification of smooth and rough surfaces as the result of rubbing'. (Mark that the words 'Snigdha' and 'Ruksha' have been translated as smooth and rough.) In Sutrás 33-36 the laws of these combinations are discussed in detail and in Sutra 37 the formation of neutral atoms from positive and negative charges, the formation of positive and negative ions and as to how the same atom behaves sometimes as electro-positive and sometimes as electro-negative are explained. According to Professor Andrade, one of the greatest problems of new chemistry is to find out the laws which will enable us to predict which combinations of protons and neutrons are stable, which unstable and which impossible. According to the Jains, the laws are the following :—

(1) A positron combines with a positron or an electron with another electron if they differ in their degrees of Snigdhatva or

Rukshatva (energy levels ?) by two units.

(2) A positively charged particle (a positron or a proton) can unite with a negative elementary particle and *vice versa.*

(3) According to the Digambar view there is no possibility of union for all combinations of elementary particles *having the same energy level,* while the Swetámbars recognize such a possibility if the union is between the particles of opposite kind.

(4) Particles at the lowest energy level do not unite,—a sort of degenerate state.

(5) The union of the various particles of different energy levels may form an odd or an even series.

(6) The power of uniting or separation is absent in combinations composed of only two elementary particles such as the neutron.

The law No. (4) recognizes the possibility of the free occurrence of the electrons and the positrons such as the conductivity electrons in the metals and the positrons occurring in the cosmic ray streams.

The elementary particles like the neutrons, the protons, the negatrons and the various mesotrons can be looked upon as formed out of the two elementary grains, the electrons and the positrons. Although it is difficult to conceive how electrons could possibly be packed together to form the mesotrons of different masses enumerated on p. 210 *f. n.* or how

a proton could be formed out of the positrons, since, as the charges are of the same sign, the tendency would be for infinite dispersion instead of abnormal condensation, but it appears that at extremely small distances the law of repulsion changes into a law of attraction as in the case of the gravitational phenomenon cited on p. 121. Further, it is on the basis of this abnormal condensation of similar charges that the formation of nuclear matter has been explained (*vide* p. 17 *ante*). The negatrons, the mesotrons or the heavy electrons furnish examples of Ruksha particles combining with Ruksha and a molecule of oxygen is an example of a Ruksha atom combining with Ruksha; protons have been formed by the union of Snigdha particles. In the nuclei of atoms we have the Snigdha and Ruksha particles together and in the neutron, we have a close union of these two. With regard to the particle like the neutron—one which is formed by the union of only two particles—it is mentioned that it has no power of uniting or separation (*vide* p. 180). In other words, a neutron cannot be broken up into a proton and an electron or two neutrons cannot unite together to form a third particle. In the various molecules of substances we have a union of Snigdha and Ruksha atoms, such as in the molecule of common salt the atoms of sodium are Snigdha and those of chlorine Ruksha. They break up as such when common salt is dissolved in water because the strength of the bond between the atoms is not great. The necessary condition for union, discovered by the Jain thinkers, is that the uniting particles must differ in their degrees

of Snigdhatva and Rukshatva by two units. These differences in degrees it is difficult to identify but it is something like the Pauli's Exclusion Principle. Fermi-Dirac Statistics gives us a means of distinguishing between the electrons of different energy levels. Not only in the electrons but also in the atoms there is a fundamental difference of energy such that we could give them different names, George, Edward, John, etc. Otherwise how can we account for the fact that in the phenomenon of radio-activity one atom lives only a few seconds and its apparently identical neighbour many years. It is due to these inner differences in atoms that molecules with different binding strengths are produced, the strengths now being measured quantitatively by the technique of Raman Effect. The formation of the isotopes, mentioned on p. 219, also points to the fact that it is probably a difference of two units in the Snigdhatva or Rukshatva which brings about a unit difference of weight in the atoms of different elements, but because the operations of union appear to be carried out either in the deep interiors of the nuclei of the atoms or in certain secret corners of the inter-stellar space, the laws of union have so far not been discovered fully.

We cannot close this summary without making reference to Sutra 32 which deals with the subject of 'relativity' under the name of Syádváda theory. The aim of this theory is to co-ordinate, unify, harmonize and synthesise the individual view-points into a practicable whole or in the words of Professor Dhruva 'in this theory the discordant notes are blended so as to make a perfect harmony.' It is

not a theory of mere speculative interest but it has a bearing upon man's psychological and spiritual life. It has been compared to the Einstein's theory of relativity but it is much simpler and less elaborate as compared with relativity. Relativity is mainly the theory of the physicist but the Syádváda theory has only a philosophical bearing. Still the contributions of Syádvàda and Relativity to the ultimate outlook on life and its problems are almost the same. According to Syádváda the existence is a huge complexity; neither can human mind properly understand it nor can the human language adequately express it. As such the absolute statements are out of court and all statements are true from a certain point of view only. According to Relativity all our terms of expression like east and west, right and left, up and down are relative; they are not the same for all the observers and under all conditions; they are not absolute but merely relative to something. Relativity is therefore the theory of the statement of general physical laws in forms common to all observers. Just as the theory of Syádváda attempts to reconcile the various conflicting schools of philosophy, not by inducing them to abandon their favourite stand-points but by proving to them that the stand-points of all others are alike tenable and represent different aspects of truth, so has the theory of Relativity shed light on age-old controversies. Whether the earth moves round a stationary sun or the sun moves round a stationary earth was a debated problem for long. According to Relativity both the statements may be right or wrong

depending upon the view-points. The truth is that the motion between the sun and the moon is relative. We may assume either the sun or the earth to be stationary depending upon the mathematical convenience.

It is worthy of note that this brilliant theory of stand-points originated with the Jain thinkers: there is hardly a counter-part of it in other systems of philosophy, oriental or occidental.

ERRATA.

The lines are counted from the top unless otherwise stated.

Page	*Line*	*For*	*Read*
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1	26	क्षपणसार	क्षपणसार
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98	20	Michiel	Michael
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137	17	than	that
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149	5	भत्याश्च	भृत्याश्च
151	14	स्वय	स्वयं
163	last	*Outlines*	*Outline*
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